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ABSTRACT

Based on a January 1993 survey of 347 two-year colleges nationwide, this report describes aspects of engineering technology and science technology education and training in the nation's two-year colleges. Following introductory materials, the first chapter estimates the number of colleges offering engineering and science programs, reviews types of programs offered, and examines trends in associate degrees. This chapter estimates that of 1,325 colleges nationwide, approximately 725 offer engineering technology and 500 offer science technology programs. Chapter 2 focuses on two-year college offerings for fields within engineering technology, finding that the most common field offered is electronics engineering, followed by computer, graphical, electrical, and mechanical engineering programs. Chapter 3 examines the relative emphasis placed by the colleges on teaching applied skills versus fundamental science and mathematics in engineering technology programs, suggesting that for all divisions the emphasis is roughly equal, while chapter 4 describes linkages between two-year colleges and businesses, indicating that one-fourth of the colleges had at least one cooperative arrangement, while one-third had some type of training or retraining agreements. Finally, chapter 5 describes science technology programs in the colleges, revealing that agricultural, chemical, and biotechnology programs accounted for half of the program offerings. Extensive data tables, information on the survey methodology, and the survey instrument are appended. (KP)

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ED 382 276

HES 17

TECHNICAL EDUCATION IN 2-YEAR COLLEGES

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Higher Education SURVEYS

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HES 17

TECHNICAL EDUCATION IN 2-YEAR COLLEGES

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March 1995

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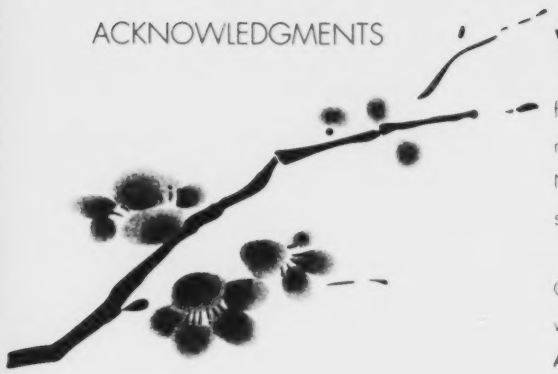


While the Division of Science Resources Studies (SRS) had overall responsibility for conducting the survey and producing this report, senior staff from other offices in the National Science Foundation (NSF) played unusually large roles in conceptualizing this study. Most notable among these was **Elizabeth Teles** of NSF's Division of Undergraduate Education who provided valuable guidance and support at all stages of the study.

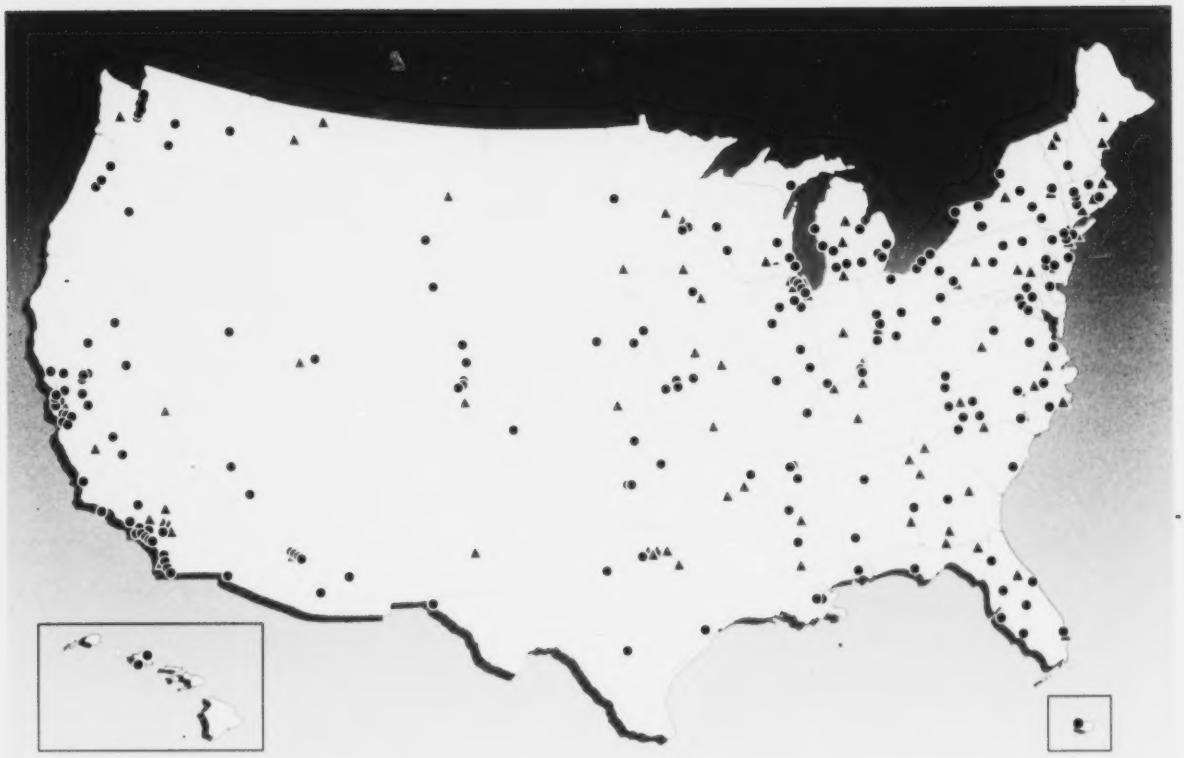
Other staff at NSF's Directorate for Education and Human Resources who provided assistance include **Robert Watson**, **Norman Fortenberry**, **Ashok Agrawal**, **Larry Suter**, **Daryl Chubin**, **James Dietz**, **Gerhard Salinger**, **Duncan McBride**, and **Karolyn Eisenstein**. While temporarily assigned to NSF, **Ray Collings** and **John Clevenger** also helped. SRS would like to thank all of these people for their cooperation and support.

Major comments, reviews, and consultations were provided by **Kenneth Brown**, Director, SRS; **Carlos Kruytbosch**, SRS; **Gregg Jackson**, Office of Technology Assessment, U.S. Congress; **Susan Forman**, Mathematical Science Education Board, National Research Council; **W. Norton Grubb**, School of Education, University of California at Berkeley; **Betty Duvall**, U.S. Department of Education; and **Steve Hunt**, U.S. Department of Education.

During the analytical phase of this report, officials at several 2-year colleges and firms helped NSF staff understand various aspects of technical education. At Dalton College in Georgia these were **Carolyn Jensen**, **Wayne Bell**, **David Hay**, and **Larry Little**; at Spartanburg Technical College in South Carolina, **Kemp Sigmon** and **Susan Graham**; at Greenville Technical College in South Carolina, **Kevin Morris**, **F.M. Rogers**, **Kay Grastie**, and **Gene Yedinak**; and at Cleveland Community College in North Carolina, **Gene Cox**, **John Swofford**, and **Mike McSwain**. **Beverley "B.J." Harrison** of the Cryovac Division of W.R. Grace & Company in Simpsonville, South Carolina, and **Barbara Lovette Wright** of General Motors Corporation in Atlanta provided valuable background information.

In SRS, **Mary Golladay** provided overall guidance for the survey and report production. **Patricia White** was the original program manager for the survey and played a central role in survey design and operations before leaving SRS. **Carin Celebuski** of Westat managed the study and, with **Lawrence Burton** of NSF, conducted the analysis and wrote this report.

At Westat, the contractor for the Higher Education Surveys (HES), **Elizabeth Farris** was Project Director, **Pat Cruz** prepared the data, and **Jacqueline Agufa** provided programming support. **Lynne Hofman** led the Westat report design team, which consisted of **Jackie Nemes**, **Ana Horton**, **Luann Grace Moore**, and **MaryBeth Glogowski**.



Thank you.

NSF extends sincere appreciation to the 2-year colleges that provided the information for this report. The symbols on this map represent colleges in the HES panel that responded to the survey: colleges symbolized by a ● are involved in engineering technology or science technology education and completed the full survey questionnaire; other respondent colleges are symbolized by a ▲. NSF would like to thank all of the HES representatives and college administrators who contributed their time to this study.

ABOUT THIS REPORT

This report describes aspects of engineering and science technology education and training in the Nation's 2-year colleges. It contains estimates of the number of 2-year colleges involved in engineering technology and science technology education; enrollment, faculty, and fields of study; and linkages between programs and local businesses and schools in the form of tech-prep, school-to-work co-ops, worker (re)training, and transfer arrangements.

It also summarizes information provided by 2-year college administrators on the teaching emphases in their programs and divisions, their commitment to technical education, and the problems facing their technology divisions.

The report is organized into five chapters:

- Chapter One summarizes national estimates of engineering technology and science technology offerings in 2-year colleges.
- Chapter Two focuses on field-level data in engineering technology.
- Chapter Three analyzes engineering technology education by the college divisions' relative emphases on teaching applied skills versus fundamental science and mathematics.
- Chapter Four considers linkages between engineering technology education and other schools and local industry, and
- Chapter Five presents data on science technology in 2-year colleges.

The estimates of technical education presented in this report are based on responses from 318 2-year colleges in the Higher Education Survey (HES) panel. The panel is a nationally representative sample of 2-year colleges that have agreed to respond to a limited number of low-burden surveys. Responses have been weighted to produce national estimates.

Because the estimates are based on a sample of institutions, they are subject to sampling error. Please see Appendix B: Technical Notes for further discussion and representative variances. Throughout the report, the following rules were applied:

- All estimates presented in the text, in figures, and in the tables in Appendix A are based on cell sizes of at least 20 unweighted cases. This rule necessitated suppression of estimates of several fields of engineering technology and science technology when fewer than 20 colleges reported programs.

- All comparisons discussed in the text and presented in the figures are statistically significant at the .05 level or below, unless otherwise noted. This means that there is at most a 1 in 20 probability that the observed differences occurred purely by chance.

Detailed data for engineering technology are reported in Appendix A. Appendix B discusses technical aspects of the survey, and Appendix C is a facsimile of the questionnaire.

Readers who wish to discuss this report, or order additional copies, are urged to call the Division of Science Resources Studies, NSF, at 703-306-1774. Electronic mail is also welcome at lburton@nsf.gov.

ABOUT THE NSF ADVANCED TECHNOLOGICAL EDUCATION PROGRAM

The National Science Foundation works with 2-year colleges in their science, mathematics, engineering, and technology programs. Such programs yield dividends for the Nation: some enrollees acquire useful skills and familiarity with science, mathematics, engineering, and technology; some graduates of these programs are ready to embark immediately on careers in the industrial workforce; and others continue their education in pursuit of baccalaureate degrees in science, mathematics, engineering, and technology.

NSF recently initiated the Advanced Technological Education (ATE) program to promote exemplary changes in technological education through support of curriculum development and program improvement for technicians being educated for the high-performance workplace of advanced technologies. Central to the ATE program is the development of strategies to strengthen 2-year college education for technicians and to strengthen science, mathematics, and technology education in secondary schools for those students who plan to enroll in technician education programs in 2-year colleges. Expanded opportunities for technicians at 4-year colleges and universities and after employment are also included.

The projects and centers supported through the ATE program will result in major improvements in advanced technological education for science and engineering technicians, build collaborations among academic institutions and between academe and industry, serve as models for other institutions, ensure that students acquire strong backgrounds in science and mathematics, and produce nationally usable educational products.

For a list of related reports from NSF, see back inside cover.

SUMMARY:
TECHNICAL EDUCATION IN 2-YEAR COLLEGES

Involvement in technology education

An estimated 725 of the Nation's 1,325 2-year colleges offer engineering technology courses. About 500 offer science technology courses. Altogether, about 800 2-year colleges offer engineering technology or science technology or both.

Fields of engineering technology and science technology

Four fields (electronics, computer, graphics, and mechanical) account for about half of all programs in engineering technology. In science technology, three fields (agricultural, chemical, and biotechnology) account for nearly half of all programs. Within colleges, the mix of programs varies widely, suggesting that colleges develop programs in close coordination with local needs.

Teaching emphasis

Nationwide, 2-year colleges emphasized the teaching of applied skills slightly more than they emphasized fundamental science and mathematics in engineering technology. Teaching emphasis within engineering technology programs seemed to be more a function of the college than of the field of study. In science technology, fields varied widely in their emphasis on teaching applied skills versus more theoretical material.

Enrollment and degrees in technology education

About one-fifth of all students enrolled in 2-year colleges with engineering technology divisions are taking technology courses or pursuing technology degrees. Course enrollment in engineering technology was about 324,000 in 1992. In science technology, course enrollment was about 91,000. After subtracting reports of decreased enrollments from increased enrollments, course enrollments in engineering technology increased between 1989 and 1992 in a net of 11 percent of programs; enrollments in science technology courses increased in a net of 30 percent of programs.

In contrast, associate's degrees in engineering technology awarded by 2-year colleges have been declining for about a decade, while science technology associate's degree awards have been flat. Several factors may explain the apparent opposite trends in associate's degrees and enrollments in these programs.

Faculty in technology education

NSF estimates that 11,700 faculty teach engineering technology in 2-year colleges, and 4,600 teach science technology. About 58 percent of the former and 43 percent of the latter are employed as full-time faculty.

In engineering technology, the predominate degree of full-time faculty is the master's (43 percent), followed by the bachelor's (23 percent). In science technology, the master's also predominates (65 percent), followed by the doctorate at 18 percent.

Commitment to technical education

Seventy percent of administrators state that within their colleges, the following goals in technical education are very important: provision of courses for transfer, remedial education, and provision of entry-level skills for employment. Fifty-five percent are highly committed to the continuing education of persons employed in science-based technical fields.

Linkages with industry and business

An estimated 53 percent of 2-year college engineering technology divisions, and 40 percent of engineering technology programs within these divisions, have arrangements to train students in a work setting. Sixty-three percent of divisions and 39 percent of programs have agreements to train or retrain workers.

In science technology, 67 percent of divisions and 45 percent of programs have arrangements to train students in a work setting. Worker training in science technology is provided by 47 percent of divisions and 33 percent of programs.

Linkages with other schools

Sixty-two percent of 2-year college engineering technology divisions, and 42 percent of programs within these divisions, have tech-prep arrangements to educate students for 2 years in high school and 2 years in college. Eighty-five percent of divisions provide for transfer credits to 4-year colleges.

In science technology, about one-half of divisions and one-third of programs offer tech-prep arrangements. Eighty percent of divisions have arranged credit transfers in science technology.

Unused capacity for linkages

Two-year colleges seem to have in place considerable unused capacity for co-ops, worker (re)training, and tech-prep programs with high schools. Assuming that all divisions could have such linkages, only 40 percent of the theoretical capacity for these arrangements is being used.

Problems in technical education at 2-year colleges

College administrators identified the poor academic preparation of their entering students as their most serious problem in both engineering technology and science technology. The next most important problems were funding for faculty salaries and instructional laboratory equipment. Issues concerning instructional equipment and facilities dominated the remainder of the problems identified by 2-year college administrators.

In contrast, administrators rated highly their faculties' communication skills and sensitivity to students' backgrounds.

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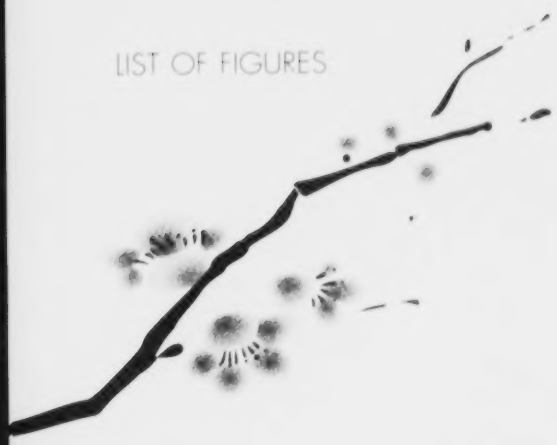

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1

OVERVIEW OF NATIONAL ESTIMATES

Two-year colleges bring three important strengths to the development of the Nation's resources in science, mathematics, engineering, and technology. First, they support a diversity of learning objectives, providing remedial courses that prepare students for upper level college work, technical education and career-oriented courses, and courses for transfer to 4-year colleges and universities. Second, they provide access to higher education for many who might not otherwise have the opportunity, and they enroll large numbers of minority and female students. Third, they take seriously their service to the community by offering courses designed to help the workforce upgrade and renew job skills and others to pursue lifelong learning.

Engineering technology and science technology education are critical components in the scheme of high-technology training in the Nation's 2-year colleges. These programs are unique because they emphasize application and adaptation of existing technology and also require knowledge of the principles on which the technologies are based.

NSF surveyed a sample of 2-year colleges in the United States to gauge the extent of their **involvement in engineering technology and science technology** education. Some 4-year institutions also have such divisions, but this study focused exclusively on activities in 2-year colleges. In the absence of widely accepted definitions, and because these educational institutions vary so widely in their course and program content, it was not possible to describe precisely the content of a standard engineering technology or science technology program. Rather, within certain general guidelines, NSF asked 2-year college administrators themselves to categorize their institutions' technical courses and programs.[1]

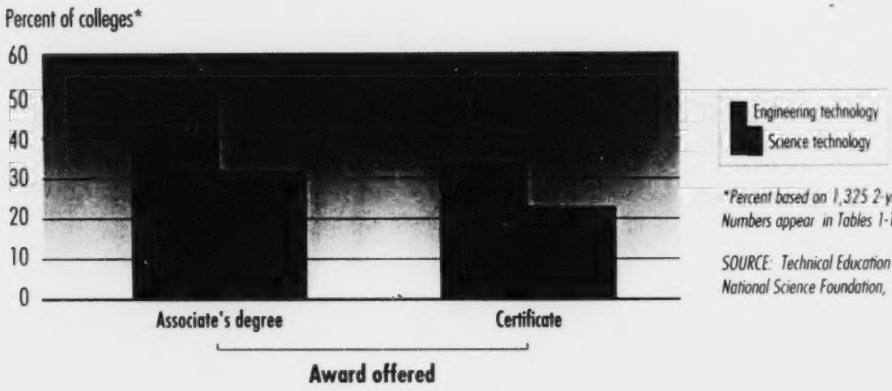
[1] The survey questionnaire in Appendix C contains the guidelines used by respondents at 2-year colleges.

Of the approximately 1,325 2-year colleges in the United States, NSF estimates that 725 offer engineering technology and about 500 offer science technology.[2] Altogether, about 800 2-year colleges offer one or the other or both, i.e., they offer at least one course in a field of engineering technology or science technology.

[2] The HES sample of colleges and universities was selected in 1990 and used descriptions based primarily on the 1987 Carnegie classification of institutions of higher education. Counts of 2-year colleges in the HES sample and in other publications of the National Science Foundation may differ slightly. Details of the HES sampling procedures are available in "Reselection of the HES Sample," from the Division of Science Resources Studies, NSF, 1990, unpublished.

Figure 1-1

Awards offered in engineering technology and science technology at 2-year colleges



*Percent based on 1,325 2-year colleges in the United States. Numbers appear in Tables 1-1 and 1-2.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

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Definitions of terms used in this report

Throughout this report certain terms will be used in discussing 2-year college engineering technology and science technology.

A **division** is the college's organizational unit that offers engineering technology or science technology courses in any field, regardless of what this unit is called in individual colleges. The term is used when referring to all of a college's engineering technology and/or science technology programs or course offerings.

A **program** in this report refers to a program of study at a 2-year college in an engineering technology or science technology field that offers a certificate, an associate's degree or both.

A **course** refers to a class offered in a field, whether or not it is part of a program offering a credential. The survey did not produce a count of courses offered by colleges, but rather of colleges offering some unknown number of courses in individual fields.

A **field** refers to a specialization within engineering technology or science technology, such as electronics engineering technology or agricultural science technology.

Most college engineering technology or science technology divisions award some kind of credential. The associate's degree is most common and is awarded by nearly all 2-year colleges offering engineering technology or science technology courses.[3] In contrast, only about two-thirds of colleges offering science technology award certificates; a similar percentage of engineering technology divisions also award certificates.

[3] But field to field differences in degree awards also exist. See Chapter 2, page 33.

Table 1-1

Engineering technology courses and awards offered in selected fields

Engineering technology field	2-year colleges offering courses*	2-year colleges offering awards in at least one field of engineering technology: Offering courses	Awarding certificates	Awarding associate's degrees	Awarding certificates or associate's degrees	Total course enrollment
	Number					
Aeronautical	74	74	29	51	74	6,130
Architectural	300	290	110	220	284	26,900
Chemical	124	124	20	84	122	25,020
Civil	296	290	77	222	290	17,800
Computer	405	387	177	318	384	52,920
Electrical	363	352	142	266	341	28,500
Electronics	585	574	235	514	571	66,500
Graphics	383	373	162	269	368	32,480
General	243	228	57	174	220	19,750
Industrial	176	173	60	111	169	99,050
Manufacturing	278	276	131	219	270	17,070
Mechanical	358	352	92	276	347	20,980
Total						
All colleges	725	691	450	687	691	324,400
All fields**	3,818	3,693	1,382	2,873	3,637	324,400

* *Includes all 2-year colleges offering courses in engineering technology, regardless of whether an award is offered.*

** *Figures for all fields combine responses from all fields including those omitted from separate presentation.*

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Table 1-2

Science technology courses and awards offered in selected fields

Science technology field	2-year colleges offering courses*	2-year colleges offering awards in at least one field of science technology: Offering courses	Awarding certificates	Awarding associate's degrees	Awarding certificates or associate's degrees	Total course enrollment
	Number					
Agricultural	216	206	154	176	200	15,700
Biotechnology	158	140	30	102	106	15,000
Chemical	216	194	35	140	142	15,700
Environmental	176	153	42	99	99	13,800
Food science	111	106	75	85	95	5,800
Hazardous materials	113	93	49	61	65	6,000
Total						
All colleges	503	446	306	427	446	90,800
All fields**	1,233	1,096	477	788	857	90,800

* *Includes all 2-year colleges offering courses in science technology, regardless of whether an award is offered.*

** *Figures for all fields combine responses from all fields including those omitted from separate presentation.*

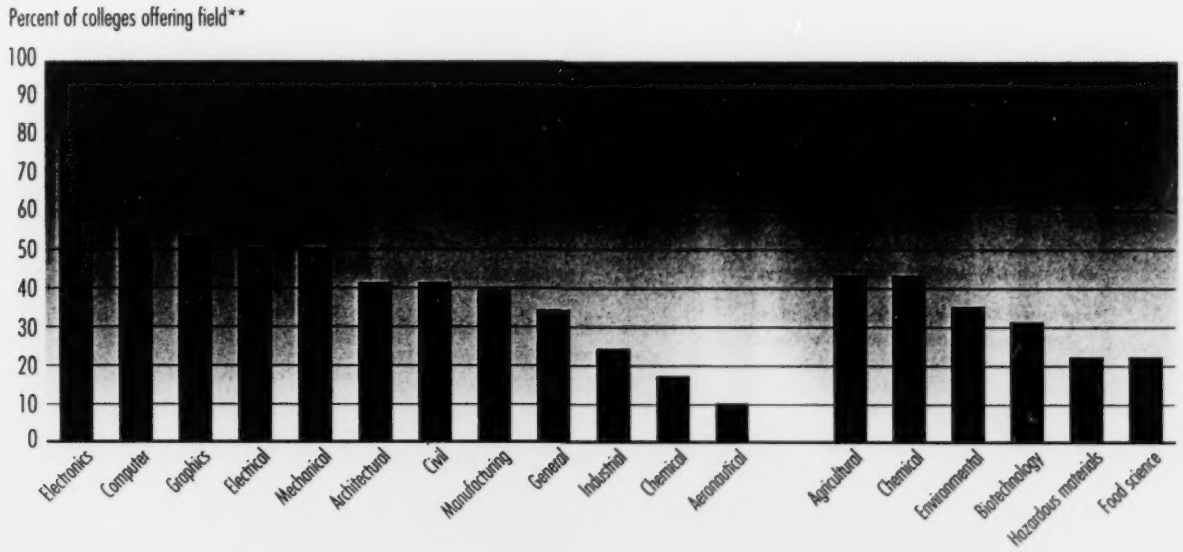
SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Certain **engineering technology and science technology fields** dominate in 2-year colleges. For example, electronics engineering is offered through 81 percent of engineering technology divisions, and it is the only field offered in 6 percent. The four next most common fields—computer, graphics, electrical, and mechanical engineering technology—are each offered in 50 to 55 percent of 2-year colleges with engineering technology divisions.

Science technology fields are somewhat more evenly distributed, but are less common overall. Two fields of science technology—agricultural and chemical—are each offered in 43 percent of 2-year colleges with a science technology division. Agricultural technology is the only field offered in 11 percent of these divisions.

Figure 1-2

Fields offered in engineering technology and science technology*



Numbers

Engineering technology			***Science technology***	
Electronics	*585*	*Civil*	*296*	*Agricultural*	*216*
Computer	*405*	*Manufacturing*	*278*	*Chemical*	*216*
Graphics	*383*	*General*	*243*	*Environmental*	*176*
Electrical	*363*	*Industrial*	*176*	*Biotechnology*	*158*
Mechanical	*358*	*Chemical*	*124*	*Hazardous materials*	*113*
Architectural	*300*	*Aeronautical*	*74*	*Food science*	*111*

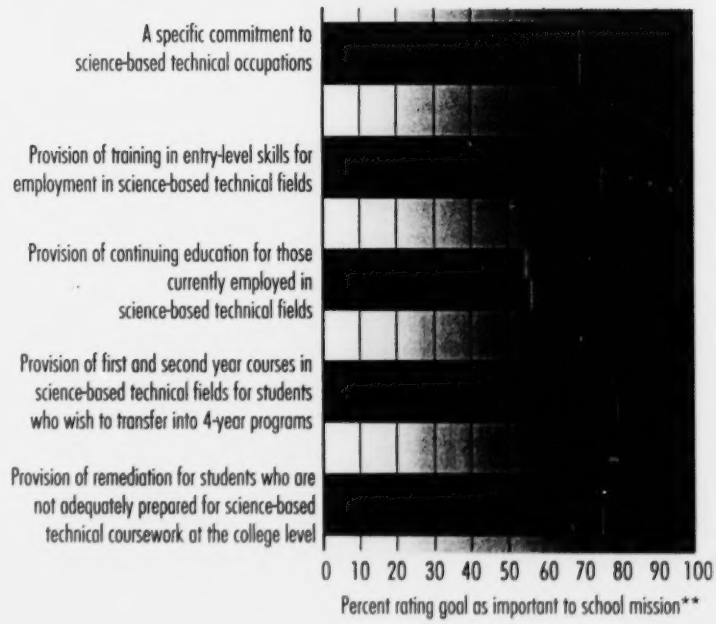
Engineering technology
Science technology

**Fields with insufficient cases for estimation omitted.*

***Numbers in table, left, are the number of 2-year colleges offering courses in that field. For engineering technology, percent is based on all 725 2-year colleges that offer any engineering technology courses. For science technology, percent is based on all 503 2-year colleges that offer any science technology courses.*

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Figure 1-3
2-year college commitment to goals of technical education*


A specific commitment to science-based technical occupations
Provision of training in entry-level skills for employment in science-based technical fields
Provision of continuing education for those currently employed in science-based technical fields
Provision of first and second year courses in science-based technical fields for students who wish to transfer into 4-year programs
Provision of remediation for students who are not adequately prepared for science-based technical coursework at the college level
0 10 20 30 40 50 60 70 80 90 100
Percent rating goal as important to school mission**

Engineering technology
Science technology

*Each goal was rated on a 5-point scale. Ratings of "4" and "5" were collapsed to represent higher than average importance.

**Percent based on 691 2-year colleges that award a certificate or associate's degree in at least one field of engineering technology and all 446 2-year colleges that award a certificate or associate's degree in at least one field of science technology. See Table 5-2 and Appendix Table A-3 for percents with high commitment.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

NSF was also interested in how important technical education is to 2-year colleges and asked college administrators to rate their college's **commitment to technology education**. Over two-thirds reported high commitment to four goals:

- A specific commitment to science-based technical occupations;
- Provision of entry-level skills for employment in technical fields;
- Provision of courses in technical fields for transfer credit; and
- Provision of remediation for students not prepared for technical coursework.

One goal was not rated highly by as many respondents. Commitment to the provision of continuing education for persons already employed in science-based technical fields was reported as important by about 55 percent.

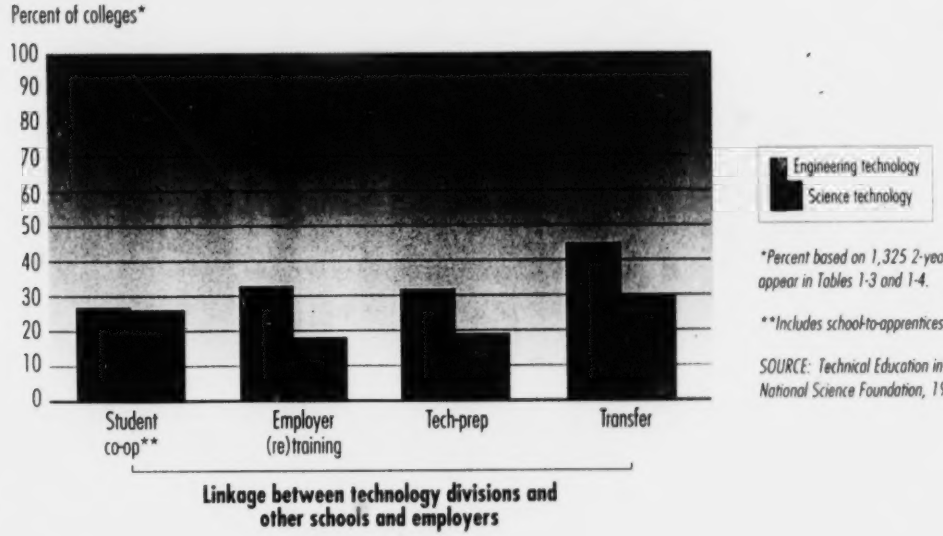
The survey also asked about the existence of formal **linkages to other schools and local industry**.[4] The responses from college administrators indicate that for engineering technology, the most common linkages were arrangements with 4-year institutions for course credit transfer in engineering technology. Nationally, about 619 colleges, or 47 percent of all 2-year colleges and 85 percent of 2-year colleges offering engineering technology courses, have such formal arrangements.

[4] The survey collected information on the existence of linkage arrangements only, not on the number of students or firms participating. An earlier study of co-op arrangements in 4-year college engineering departments found student participation in co-ops to be quite low (see HES 16, Undergraduate Education in Electrical, Mechanical, and Civil Engineering, NSF 1994).

Greater detail on these linkages is presented throughout this report. For engineering technology, Chapter 2 discusses field-level linkages. Chapter 3 contrasts patterns of linkages based on teaching emphases of 2-year colleges, and Chapter 4 discusses an analytical variable constructed from patterns of linkages. Chapter 5 presents linkages by field for science technology programs.

Figure 1-4

Special arrangements in engineering technology and science technology at 2-year colleges



*Percent based on 1,325 2-year colleges in the United States. Numbers appear in Tables 1-3 and 1-4.

**Includes school-to-apprenticeship programs and feeder programs.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Table 1-3

Engineering technology linkages with businesses and with other schools

Engineering technology field	2-year colleges offering courses*	Linkages with businesses: Offer co-op or work-based program	Linkages with businesses: Have arrangements to train workers	Linkages with schools: Tech-prep arrangements with high schools	Linkages with schools: Arrangements for student transfer
	Number				
Aeronautical	74	27	11	31	55
Architectural	300	114	81	135	226
Chemical	124	33	38	37	85
Civil	296	102	65	66	226
Computer	405	177	161	162	283
Electrical	363	166	163	126	227
Electronics	585	262	279	317	420
Graphics	383	143	143	199	230
General	243	54	34	72	185
Industrial	176	66	82	71	136
Manufacturing	278	120	160	140	186
Mechanical	358	150	156	127	247
Total					
All colleges	725	378	452	438	619
All fields**	3,818	1,488	1,462	1,550	2,600

** Includes all 2-year colleges offering courses in engineering technology, regardless of whether an award is offered.*

*** Figures for all fields combine responses from all fields including those omitted from separate presentation.*

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Other arrangements in engineering technology include the following:

- Approximately one-fourth of 2-year colleges (378) have cooperative arrangements with industry or trade unions to train students in a work setting;
- Some 452 colleges have agreements with industry to train or retrain workers; and
- About 438 colleges have tech-prep arrangements with high schools.

In science technology, 400 2-year colleges have arrangements for course credit transfer to 4-year institutions. Cooperative, work-based training of students seems to be more common in science technology divisions than in engineering technology divisions. Sixty-seven percent of colleges with science technology divisions have such arrangements; the comparable measure for colleges offering engineering technology is 52 percent.

Table 1-4

Science technology linkages with businesses and with other schools

Science technology field	2-year colleges offering courses*	Linkages with businesses		Linkages with schools	
		Offer co-op or work-based program	Have arrangements to train workers	Tech-prep arrangements with high schools	Arrangements for student transfer
	Number				
Agricultural	216	158	89	109	146
Biotechnology	158	53	31	41	129
Chemical	216	50	41	56	161
Environmental	176	65	37	42	123
Food science	111	75	55	55	72
Hazardous materials	113	48	57	20	54
Total					
All colleges	503	338	237	246	400
All fields**	1,233	550	405	409	858

* *Includes all 2-year colleges offering courses in science technology, regardless of whether an award is offered.*

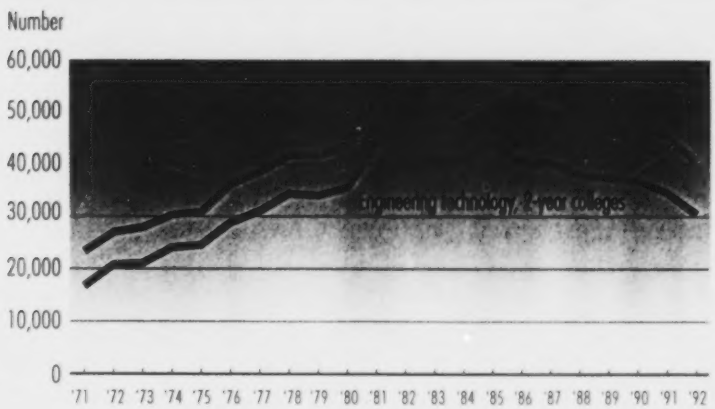
** *Figures for all fields combine responses from all fields including those omitted from separate presentation.*

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

[5] NCES and NSF definitions of fields of engineering technology do not exactly coincide.

Engineering and science technology programs in 2-year colleges in the United States exhibit seemingly contradictory **trends in associate's degree awards and enrollments**. The National Center for Education Statistics (NCES) of the U.S. Department of Education has reported a gradual decline in awards of engineering technology associate's degrees by 2-year colleges since 1982. Science technology associate's degree awards have been flat since 1988, at about 850 per year.[5]

Figure 1-5
Engineering technology associate's degrees awarded: 1971-92*



*Tabulations by National Science Foundation/SRS; data from Department of Education/National Center for Education Statistics: Survey of Degrees and Other Formal Awards Conferred, and Completions Survey.

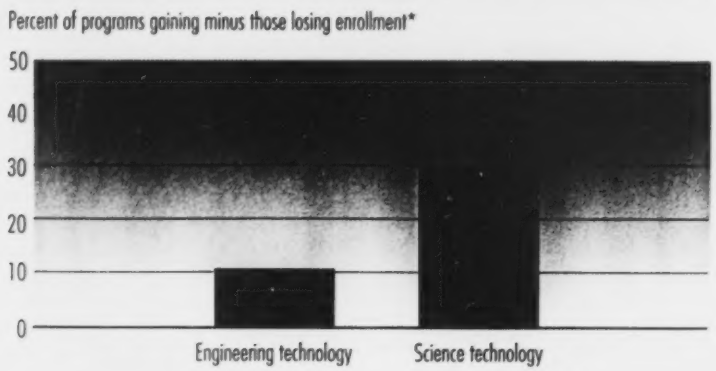
SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

In contrast to these degree trends, college administrators responding to the NSF survey reported that most of their engineering technology programs gained in course enrollment between 1989 and 1992.[6] Of all engineering technology programs, a net of 11 percent (after programs with declining enrollments were taken into account)—or 400 programs—reported gains in enrollment between 1989 and 1992 (Appendix Table A-13). Only in mechanical and architectural engineering technology did programs losing enrollment outnumber programs gaining enrollment over the 3-year period. Enrollments in science technology increased in an even larger percentage of programs, 30 percent.

[6] Readers are reminded that these are ordinal data from counts of numbers of programs with decreasing and increasing enrollments; the actual magnitudes of these enrollment changes were not measured in the NSF survey. NSF asked survey respondents whether the course enrollment for that field has gone up by 5 percent or more, has stayed the same, or has gone down by 5 percent or more, between fall 1989 and fall 1992. In contrast, the NCES degree data are actual counts of degrees awarded.

Figure 1-6

Net change in enrollment in engineering technology and science technology programs: 1989-92



Net numbers	
Engineering technology . . 394	Science technology 296

**Percent is based on programs in 691 2-year colleges with engineering technology programs and 446 2-year colleges with science technology programs. Numbers in table above are the net of programs gaining enrollment minus those losing enrollment. See the questionnaire in Appendix C, question 5 for instructions to respondents.*

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Reasons for these apparently opposite trends are unknown. It is possible that there are increasing rates of noncompletion, or student transfer before completion, or increasing completions of certificates rather than associate's degree awards.[7] It is also possible that enrollees are completing the associate's degree at far slower rates than heretofore, or that they are increasingly enrolling to obtain only some specific course or skill.

Other sections of this report suggest specific factors that may help explain the different trends in enrollments and associate's degrees. The discussion later in this chapter of problems in engineering technology instruction at 2-year colleges notes administrators' dissatisfaction with student retention in degree programs, a situation suggesting that students may enroll in courses to obtain some specific coursework rather than an associate's degree. Chapter 3 points out a relationship between the teaching emphasis of a college and its enrollment trends. Chapter 4 discusses the important role of certificate programs in linkages between 2-year colleges and local industry and describes the relationship between a college's integration with the community and its enrollment trends.

Total national course enrollment in engineering technology at 2-year colleges was about 324,000 in fall 1992.[8] Nationally, about one-fifth of all students enrolled in 2-year colleges with engineering technology divisions were taking technology courses. Science technology course enrollment was about 91,000 in fall 1992.

[7] W. Norton Grubb, Director, Center for Research in Vocational Education, University of California-Berkeley, personal communication, 19 December 1994.

[8] Since the survey asked about "course enrollment," these enrollment figures contain an unknown amount of duplication.

Total **faculty** in engineering technology nationally in 2-year colleges was about 11,700, of which about 6,800—or 58 percent—were full-time employees. Of these full-time faculty, the predominant degree was the master's (43 percent), followed by the bachelor's (23 percent).

Table 1-5

Course enrollment and faculty in engineering technology and science technology divisions*

Characteristic	Engineering technology	Science technology
Enrollment		
Total course enrollment	324,400	90,800
Mean per college	470	200
Faculty		
Total technology faculty	11,700	4,600
Mean per college	17	11
Full-time faculty	6,800	2,000
Mean per college	10	5
Part-time faculty	4,700	2,400
Mean per college	7	6

*Divisions that award either a certificate or associate's degree.

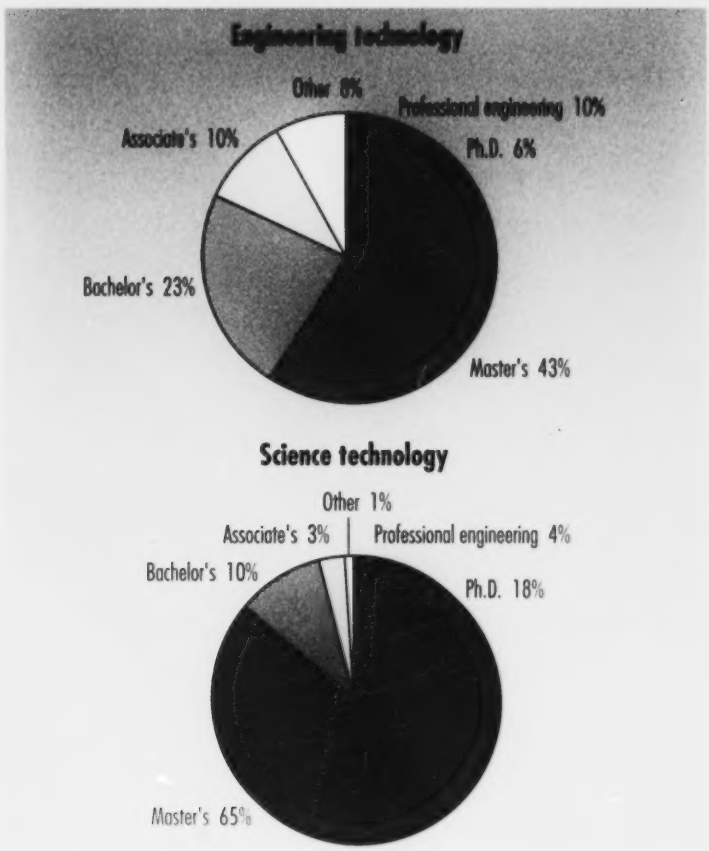
NOTE: All data are for fall 1992.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Science technology faculty in 2-year colleges numbered about 4,570, of which about 56 percent were full-time employees. Among full-time faculty, the master's degree dominated (65 percent), followed by the doctorate (18 percent).[9]

Figure 1-7

Degree level of full-time engineering technology and science technology faculty in 2-year colleges



NOTE: Percents may not add to 100 due to rounding. "Other" category includes faculty with unknown degree level. See also Figure 5-6.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

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NSF was also interested in the **problems in instruction** faced by 2-year college administrators. Potential problem areas addressed five broad topics: student background and interest, curriculum quality, instructional equipment, facilities, and faculty resources. Responses to these questions provided for the identification of highly rated aspects of 2-year college technical instruction, the most serious problems administrators face, and the comparison of responses from 2-year college administrators with responses from 4-year college engineering deans from an earlier HES survey.

How the problems were measured

NSF developed a list of 24 aspects of instruction[10] and then asked two questions to elicit two types of information about these 24 aspects:

First, college administrators were asked to rate the quality of each of the 24 aspects of instruction individually on a scale of 1 to 5, with "1" representing "very poor" and "5" representing "very good." This approach resulted in identification of both problematic and high-quality aspects of 2-year college instruction in engineering technology and science technology.

Second, from the list of 24, college administrators were asked to "pick the 5 aspects from the whole list that present the greatest problems for your engineering technology/science technology program and rank them, with a '1' assigned to the greatest problem, a '2' to the second greatest, etc." This approach required that the items be evaluated one against the other and provided a rank ordering of the problems as perceived by the administrators.[11]

The two approaches identified somewhat different sets of problems. The ratings in the first approach reveal the administrators' assessments of the quality of each aspect without regard to its impact on instruction (Appendix Tables A-27 and A-28). The rankings in the second approach identify those problems that they believe have the most negative impact on instruction.

For example, a comparison of the mean ratings of the 24 aspects in the first approach (Table 1-7) shows that administrators gave lower assessments to other aspects of instruction than they gave to funding for faculty salaries. But Table 1-8 shows that in the second approach, administrators ranked funding for faculty salaries as the third greatest problem hindering 2-year college instruction in engineering and science technology. They did not rate funding for faculty salaries as low as they did other aspects of their programs, but they ranked it among the greatest problems they face in their engineering and science technology programs.

[10] See the questionnaire, Appendix C, questions 8 and 16.

[11] NSF recoded the responses to provide a rank ordering, as explained in National Science Foundation, *Undergraduate Education in Electrical, Mechanical and Civil Engineering* (HES 16), NSF, 1994, page 34.

Table 1-6

Highly rated aspects of engineering technology and science technology education*

Rank	Engineering technology	Science technology
1.	Retention of qualified faculty	Oral communication skills of faculty
2.	Appropriateness of class sizes	Retention of qualified faculty
3.	Oral communication skills of faculty	Faculty sensitivity to students with diverse backgrounds
4.	Faculty sensitivity to students with diverse backgrounds	Appropriateness of class sizes
5.	Amount of computer equipment	Recruitment of qualified faculty

**Ratings are from 2-year colleges with engineering technology divisions (N=691) and science technology divisions (N=446). See the questionnaire in Appendix C for a list of the aspects rated.*

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

[12] But in contrast with these ratings, the adequacy of faculty salaries was ranked among the top problems the administrators face. See Table 1-8, page 22

Among the aspects of instruction rated highly by college administrators, several concerned faculty: their retention, communication skills, and sensitivity to students with diverse backgrounds.[12] They were also apparently satisfied with the size of classes. The highly rated aspects of instruction in engineering technology and in science technology were almost identical.

In a previous study, NSF asked the chairs of 4-year undergraduate departments in electrical, mechanical, and civil engineering to rate a virtually identical list of aspects of undergraduate instruction in their departments.[13] Patterns of differences and similarities between the three sets of responses suggest some general observations:

- Ratings of laboratory equipment and faculty/staff resources by 4-year college chairs in the three engineering departments and 2-year college administrators of engineering technology divisions were similar.
- Two-year college administrators seemed somewhat more satisfied with the quality and amount of their instructional laboratory space and lecture facilities in engineering technology than were the 4-year college engineering chairs.
- Two-year college administrators rated all four factors relating to quality of students and their retention lower than did the chairs in baccalaureate engineering programs.
- Computer equipment—its quality, amount, and accessibility—was rated lower in science technology divisions than in both engineering technology divisions in 2-year colleges and engineering departments in 4-year colleges.

[13] See National Science Foundation, *Undergraduate Education in Electrical, Mechanical, and Civil Engineering* (HES 16), NSF, 1994.

Table 1-7

Problems in 4-year engineering programs compared with problems in 2-year engineering-technology and science technology divisions

Aspect of instruction	4-year departments in electrical, mechanical, and civil engineering	2-year college engineering technology divisions	2-year college science technology divisions
	Mean rating		
Students			
Academic preparation of entering students	3.1	2.4	2.6
Student interest and motivation	3.7	3.4	3.6
Computer background of students	3.1	2.5	2.6
Retention rates of majors	3.4	3.0	3.2
Curriculum			
Quality of instructional materials*	4.0	3.7	3.6
Opportunities for innovation in the curriculum	3.5	3.5	3.7
Impact of accreditation requirements on curriculum development	3.2	3.6	3.5
Laboratory equipment			
Quality of computer equipment	3.8	3.7	3.2
Amount of computer equipment	3.5	3.5	2.9
Accessibility of computer equipment	3.8	3.7	3.0
Quality of other instructional laboratory equipment	3.3	3.4	3.3
Amount of other instructional laboratory equipment	3.1	3.3	3.0
Accessibility of other instructional laboratory equipment	3.4	3.4	3.1
Funding for instructional laboratory equipment	2.4	2.5	2.3
Facilities			
Quality of instructional laboratory space	3.4	3.6	3.4
Amount of instructional laboratory space	3.2	3.4	3.3
Demonstration capabilities of lecture facilities	2.7	3.4	3.3
Faculty/staff resources			
Appropriateness of class sizes	3.6	4.0	3.8
Recruitment of qualified faculty	3.8	3.7	3.7
Retention of qualified faculty	4.0	4.1	3.9
Funding for faculty salaries	2.7	3.1	3.0
Oral communication skills of faculty	4.0	3.9	3.9
Faculty sensitivity to students with diverse backgrounds	3.9	3.9	3.9

*There were slight wording differences on the two questionnaires.

NOTE: Mean ratings on a scale of 1 to 5, with "1" meaning "very poor" and "5" meaning "very good." Responses for 4-year engineering programs from a survey of all electrical, mechanical, and civil engineering departments in the U.S. Responses for 2-year programs are from a sample of U.S. 2-year colleges offering programs in engineering technology and/or science technology.

SOURCE: Higher Education Survey of Undergraduate Instruction in Electrical, Mechanical, and Civil Engineering (HES 16), National Science Foundation, 1994, unpublished tabulations, and Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

The 10 most serious problems facing engineering technology divisions at 2-year colleges concerned students, physical and faculty resources, and one aspect of integration with the community.

According to administrators, students' overall academic preparation—and specifically their computer backgrounds—as well as their retention through a program of study, were among the most serious problems in engineering technology. The amount of computer equipment and other, noncomputer instructional lab equipment were also viewed with concern.

Administrators ranked as their seventh most serious problem the lack of opportunities for cooperative educational internships.[14]

Patterns of responses between science technology and engineering technology divisions were almost identical. However, in contrast to engineering technology, administrators did not rank retention of students among the top 10 problems in science technology instruction.

[14] Coops and other types of linkages with schools and businesses are also discussed in Chapter 4.

Table 1-8

Ten most serious problems in 2-year college engineering technology and science technology education*

Top three

Rank

1. Academic preparation of entering students
2. Funding for instructional laboratory equipment
3. Funding for faculty salaries

Engineering technology

Rank

4. Retention rates of majors
5. Amount of computer equipment
6. Computer background of students
7. Opportunities for cooperative programs/internships
8. Amount of noncomputer laboratory equipment
9. Quality of computer equipment
10. Amount of instructional laboratory space

Science technology

Rank

4. Amount of computer equipment
5. Amount of instructional laboratory space
6. Amount of noncomputer laboratory equipment
7. Quality of instructional laboratory space
8. Opportunities for cooperative programs/internships
9. Quality of computer equipment
10. Computer background of students

*Rankings are from 2-year colleges with engineering technology divisions (N=691) and science technology divisions (N=446). See the questionnaire in Appendix C for a list of the aspects ranked.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

2

FIELDS IN ENGINEERING TECHNOLOGY

The **distribution of engineering technology programs by field** is uneven. Five fields are offered in over 50 percent of 2-year colleges with engineering technology programs. But beyond these five, other fields are not so widely available. About one-fourth of 2-year colleges with any program offer industrial engineering technology, and fewer than one-fifth offer chemical engineering technology.

Programs in electronics engineering technology are most common, being offered in 83 percent of colleges that have an engineering technology division; electronics engineering is the only engineering technology program in 6 percent of colleges with engineering technology (about 40 colleges). NSF's survey of a sample of the 1,325 2-year colleges yielded sufficient information for separate estimates of 12 fields of engineering technology and a category of "other"—the sum of fields too small to report separately.[15, 16]

Two-year college engineering technology divisions are highly varied, that is, it appears that individual colleges develop their technology divisions with an eye to the needs of local businesses and industry. The average 2-year college

[15] See "Engineering technology fields," page 26, for a list of the suppressed fields.

[16] Readers are reminded that program in this report refers to a program of study in an engineering technology field at a 2-year college that offers a certificate, an associate's degree, or both. Course refers to a class offered in a field, whether or not it is part of a program offering a credential. The survey did not produce a count of courses offered by colleges, but rather of colleges offering some unknown number of courses in individual engineering technology fields.

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with an engineering technology division has programs in five fields, but the combination of fields varies widely. For example, of 2-year colleges offering engineering technology programs,

- Fewer than half have programs in both of the top two fields, and
- About a quarter have programs in all of the three top fields.

Table 2-1
Engineering technology programs, by field

Engineering technology field	Programs		Colleges with programs (N=691)
	Number	Percent	Percent
Total	3,637	100	100
Electronics	571	16	83
Computer	384	11	56
Graphics	368	10	54
Mechanical	347	10	51
Electrical	341	9	51
Civil	290	8	42
Architectural	284	8	42
Manufacturing	270	7	40
General	220	6	33
Industrial	169	5	25
Chemical	122	3	18
Aeronautical	74	2	11
All other	197	5	29

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Engineering technology fields

The survey questionnaire asked respondents to specify in which of 15 engineering technology fields their 2-year college offered courses. Respondents could also select one open-ended "other" category. The specified fields were

- Aeronautical
- Architectural
- Chemical
- Civil
- Computer
- Electrical
- Electronics
- Graphics
- General
- Industrial
- Manufacturing
- Mechanical
- Marine
- Mining/metallurgy
- Nuclear

The questionnaire instructed respondents to include any courses in these fields that teach fundamental scientific, mathematical, or engineering concepts and to exclude courses that were exclusively applied or in clinical health fields.

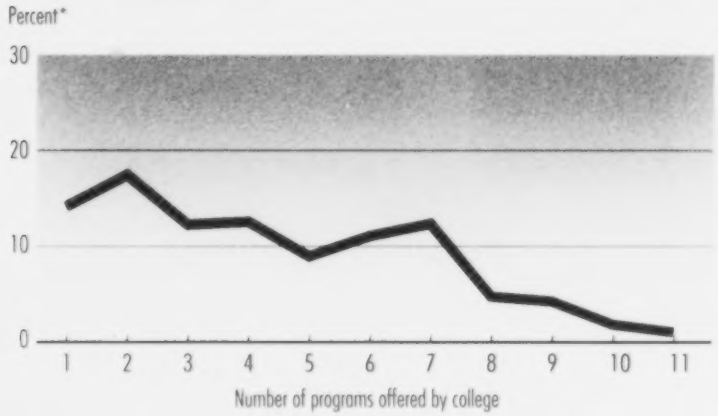
NSF reviewed the write-in responses and reclassified a number of these responses into the specified field codes. Several were broken out for separate analysis.

Because these data were collected from a sample of 2-year colleges, the resulting unweighted counts for some fields were too small to produce reliable national estimates. These fields, from the original list in the questionnaire, were marine, mining/metallurgy, and nuclear engineering technologies; and, from write-in fields added by respondents, automotive, building construction, energy systems, and quality control engineering technologies.

The survey also collected data on science technology fields, discussed in Chapter 5.

Technology division sizes ranging from one to seven programs account for 88 percent of all colleges with engineering technology divisions. Two-year colleges offering engineering technology instruction in eight or more programs are rare.

Figure 2-1
Size of engineering technology divisions at 2-year colleges



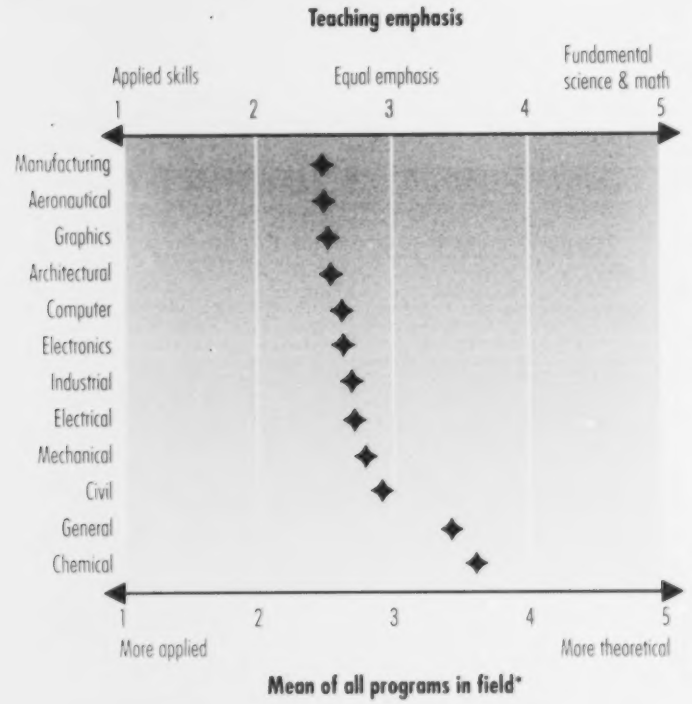
*Percent is based on 691 2-year colleges with divisions in engineering technology. Tabulations are unpublished.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

NSF was also interested in the teaching orientation of 2-year college engineering technology. Did the teaching in these programs emphasize the learning of applied skills, or did it emphasize the learning of science and mathematics fundamentals?

The average **teaching emphasis in engineering technology** programs by field in the United States is slightly applied. Of the 12 fields analyzed, only general and chemical engineering technology tend to emphasize fundamental science and mathematics more than they emphasize applied skills.

Figure 2-2
Teaching emphasis in engineering technology fields

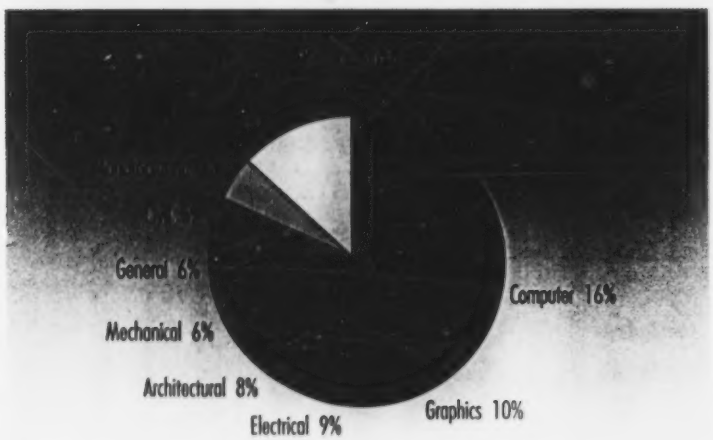


*Mean based on programs in each field. See Appendix Table A-30 for numbers of programs and Appendix Table A-7 for mean teaching emphasis.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Figure 2-3

Course enrollment in engineering technology at 2-year colleges, by field*



	Number	Mean per college
Electronics	66,500	120
Computer	52,920	160
Graphics	32,480	100
Electricol	28,500	100
Architectural	26,900	110
Mechanical	20,980	70
General	19,750	110
Civil	17,800	70
Manufacturing	17,070	70
Industrial	9,050	60
Aeronautical	6,130	100
Chemical	5,020	50
Other	21,320	—

**Respondents were asked to report the sum of all enrollment in all courses within each field. This may have resulted in duplicate counting of students who were enrolled in more than one course at the same time.*

NOTE: All data are for fall 1992. Percents may not add to 100 due to rounding.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Among some 324,000 students,[17] **enrollment in engineering technology fields** is greatest in electronics (21 percent of total) and computer courses (16 percent).[18] All other fields each account for 10 percent or less of the total course enrollment in engineering technology in 2-year colleges.

[17] This estimate of total course enrollment includes an unknown amount of duplicate counting of individuals.

[18] Compare with enrollment trends discussed in Chapter 1, page 13.

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Figure 2-4

Course enrollment trends in engineering technology, by field: 1989-92

Numbers			
All programs	394	Electrical	46
Mechanical	−10	General	27
Architectural	0	Chemical	15
Electronics	6	Aeronautical	14
Industrial	6	Graphics	93
Civil	18	Computer	126
Manufacturing	30		

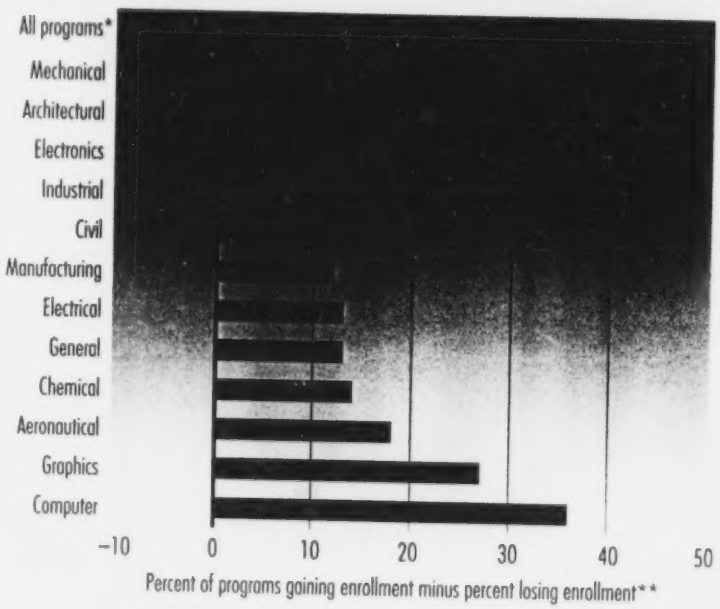


*Figure for all programs combines responses from all fields, including those omitted from separate presentation.

**Percent is based on programs in each field. Respondents were instructed to report gains or losses of 5 percent or more within the 3-year period. See Appendix Table A-13 for percents and Appendix Table A-29 for numbers of programs.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

[19] Too few reports were obtained for some fields, and these were not broken out for separate presentation.

Respondents reported more programs with growing enrollment than with declining enrollment. Taking all programs into account, a net of about 11 percent of programs in all fields experienced enrollment growth between 1989 and 1992. Only in mechanical engineering technology did programs declining in enrollment outnumber those growing. Computer, graphics, and aeronautical engineering technology reported the largest net percentage of programs increasing in enrollment.[19]

More larger programs than smaller ones reported growth in enrollment. NSF divided programs within each field into two groups—those with enrollments below the median (small) and above it (large). Nationally, small programs in some fields reported net course enrollment increases, but all of the net declines in enrollment occurred in small programs. Large programs in virtually all fields reported net increases.

Table 2-2

Growth in course enrollments in selected fields of engineering technology, by size of program: 1989-92

Engineering technology field	Small programs*	Large programs*
	Percent**	
Electronics	3	0
Computer	26	43
Graphics	9	46
Mechanical	–16	16
Electrical	12	13
Civil	–4	23
Architectural	5	7
Manufacturing	16	9
General	8	23
Industrial	–7	23
Chemical	–5	30
Aeronautical	6	15

*Programs within each field were categorized as small if they had lower course enrollment than the median for that field and as large if their course enrollment was higher than the median for that field.

**Programs gaining in enrollment net of those losing enrollment.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

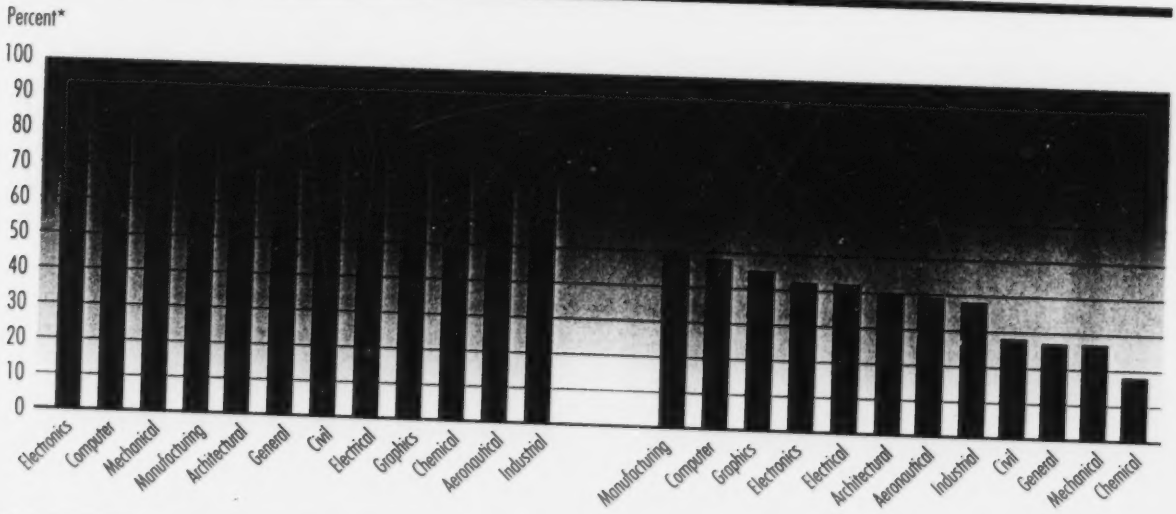
Virtually all 2-year colleges with engineering technology divisions also award credentials—associate's degrees or certificates. When classified by field, differences in **patterns of awards** are apparent. For example, 90 percent of 2-year colleges offering electronics engineering technology offer the associate's degree in that field, compared to less than 70 percent offering associate's degrees in aeronautical and industrial engineering technologies.

Certificates, which in every engineering technology field are less likely to be offered than associate's degrees, are offered in nearly 50 percent of manufacturing and computer engineering programs, but in less than 20 percent of chemical engineering programs.[20]

[20] Certificates are discussed in Chapter 4 as indicators of integration with the community, especially linkages between 2-year colleges and local industry.

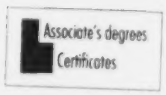
Figure 2-5

Associate's degree and certificate programs in engineering technology at 2-year colleges, by field



Numbers

Associate's degree			
Electronics	514	*Graphics*	269
Computer	318	*Chemical*	84
Mechanical	276	*Aeronautical*	51
Manufacturing	219	*Industrial*	111
Architectural	220		
General	174	***Certificate***	
Civil	222	*Manufacturing*	131
Electrical	226	*Computer*	177
		Graphics	162
		Electronics	234
		Electrical	142
		Architectural	110
		Aeronautical	29
		Industrial	60
		Civil	77
		General	57
		Mechanical	92
		Chemical	20



*Numbers in table, left, are the number of 2-year colleges with an award in that field. Percent is based on programs in each field. See Appendix Table A-29 for numbers of programs and Appendix Table A-9 for percent with awards.

SOURCE: Technical Education in 2-Year Colleges (HES 17). National Science Foundation, 1995.

Commitment to technology education

NSF developed a scale of college commitment to technology education from administrators' ratings of the importance of five goals to their college's mission.[21] Administrators rated the importance of each of the five goals listed on Figure 1-3 on a scale of 1 to 5. Thus, each college could attain a score of 5 to 25 when the responses for each goal were summed. Scores less than 16 were labeled "low"; between 16 and 19, "medium"; and 20 or more, "high" commitment. The resulting (weighted) distribution for colleges offering engineering technology programs were

Low:	108 colleges
Medium:	195 colleges
High:	388 colleges

This analytical construct is used throughout this report.

[21] Question 3 of the questionnaire. Appendix C.

Table 2-3

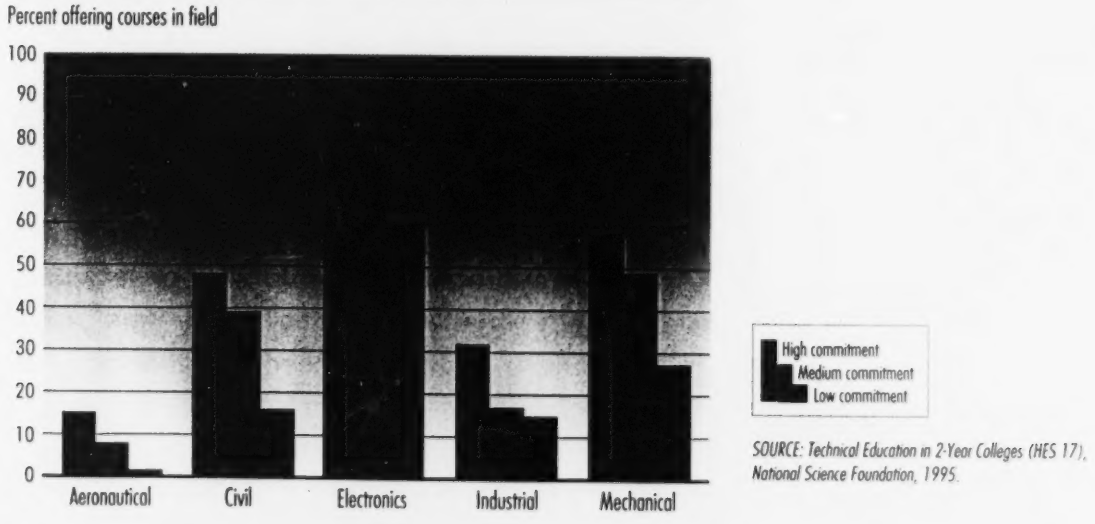
Institutional characteristics of 2-year colleges, by commitment to technology education

Characteristic	2-year college engineering technology divisions (N=691)	College commitment to technology education: High (N=388)	Medium (N=195)	Low (N=108)
	Number			
Number of engineering technology programs offering certificates or associate's degrees				
Mean	5	5	4	3
Range	1-11	1-11	1-9	1-7
Mean enrollment in technology courses				
Per college	470	570	365	320
Per program	90	100	80	80
Mean number of technology faculty				
Per college	17	21	14	12
Per program	3	3	3	3

SOURCE: *Technical Education in 2-Year Colleges* (HES 17), National Science Foundation, 1995.

Figure 2-6

Courses offered in selected fields, by college commitment to technology education



SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

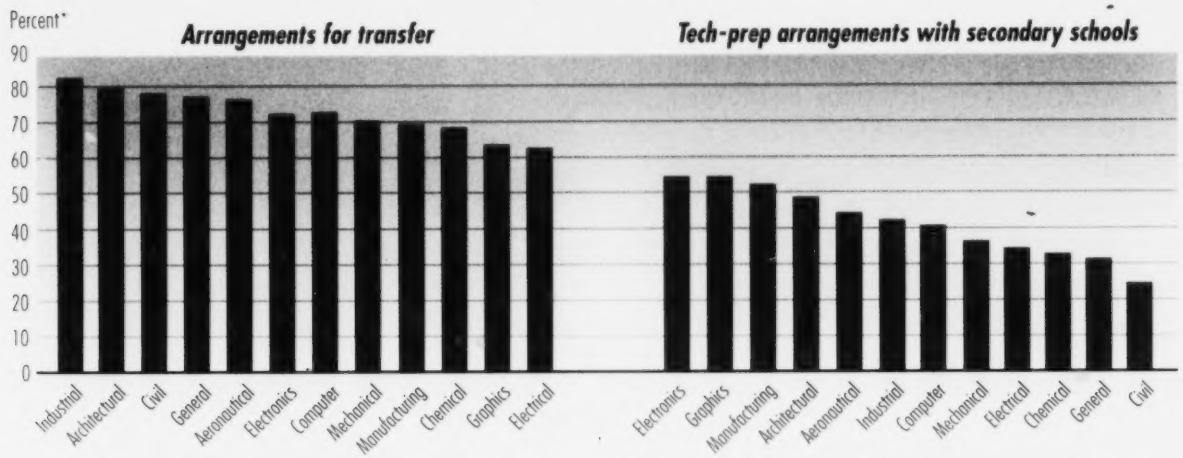
The most common formal **linkages to other educational levels** are arrangements to transfer engineering technology credits to 4-year colleges. Eighty-six percent of 2-year college engineering technology divisions, and 70 percent of the programs in these divisions, have articulation agreements or other arrangements with 4-year colleges for transfer of students to 4-year degree programs within the field (Appendix Table A-21). At the field level, these linkages range from a low of 62 percent in electrical to a high of 82 percent in industrial engineering technology.

Less common are arrangements with secondary schools for tech-prep programs.[22] Sixty-two percent of divisions have such arrangements in at least one program field; of all programs, 42 percent have such arrangements (Appendix Table A-19). Availability of tech-prep arrangements varies widely by field. They were offered by 24 percent of civil engineering technology programs and 52 percent of manufacturing engineering technology programs.

[22] This terminology was introduced to questionnaire respondents with the following statement: "Indicate whether your institution has articulation agreements or arrangements with any secondary districts or schools to jointly offer tech-prep programs that provide at least 2 years of secondary and 2 years of postsecondary courses leading to associate's degrees or 2-year certificates in that field."

Figure 2-7

Linkages in engineering technology between 2-year colleges and other educational levels, by field



Numbers

Arrangements for transfer to 4-year colleges		***Tech-prep arrangements with secondary schools***			
Industrial	*136*	*Manufacturing*	*186*	*Architectural*	*133*
Architectural	*223*	*Chemical*	*83*	*Aeronautical*	*31*
Civil	*220*	*Graphics*	*226*	*Industrial*	*68*
General	*170*	*Electrical*	*215*	*Computer*	*150*
Aeronautical	*55*			*Mechanical*	*121*
Electronics	*409*			*Electrical*	*117*
Computer	*271*			*Chemical*	*37*
Mechanical	*240*			*General*	*67*
				Civil	*66*

**Numbers in table, left, are the number of 2-year colleges with both a program and a linkage in that field. Percent is based on programs in each field. See Appendix Table A-29 for numbers of programs and Appendix Tables A-21 and A-19 for percent with linkages.*

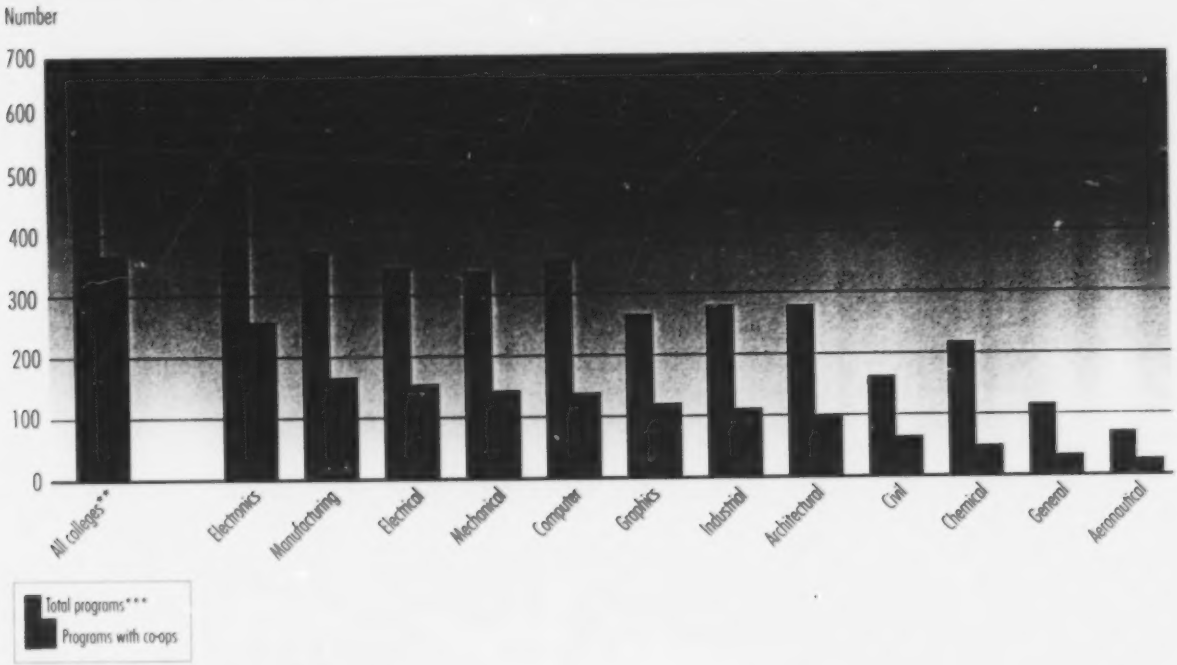
SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

About 370 2-year colleges with engineering technology divisions (53 percent) have some cooperative arrangement with industry to train students in at least one field. The availability of **co-op training** arrangements varies widely by field, but never reaches 50 percent. Divisions have negotiated such arrangements in 40 to 45 percent of programs in six fields: electronics, computer, electrical, mechanical, manufacturing, and architectural engineering technology.

The two fields with the lowest percentage of co-op training agreements with industry—chemical and general engineering technology—are also the fields more oriented toward teaching fundamental science and mathematics (see Figure 2-2, page 28).

Figure 2-8

Co-op training arrangements* in 2-year colleges in engineering technology, by field



*Includes school-to-apprenticeship programs and feeder programs.

**Includes all 2-year colleges with a program.

***See Appendix Table A-29 for numbers of programs and Appendix Table A-15 for cooperatives.

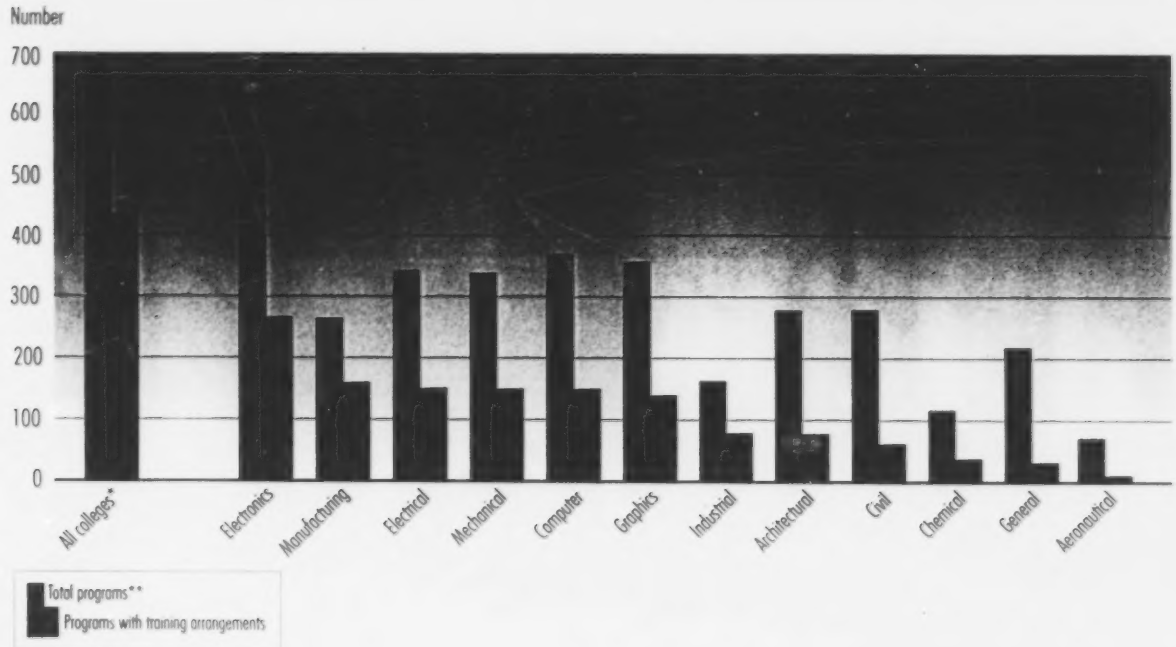
SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

More engineering technology divisions have **training arrangements with industry** than have co-op programs—about 440 of the total 691, or 64 percent. On the field level, some 60 percent of manufacturing engineering technology programs have training arrangements; fewer than 50 percent in all other fields have such arrangements. Formal training or retraining arrangements with industry are particularly rare in general engineering and aeronautical engineering technology programs (15 percent each) and are below 30 percent in civil and architectural engineering technology programs.[23]

[23] Further details on the unused capacity for such arrangements are in Chapter 1, page 9.

Figure 2-9

Arrangements with industry to train or retrain workers in 2-year colleges in engineering technology, by field



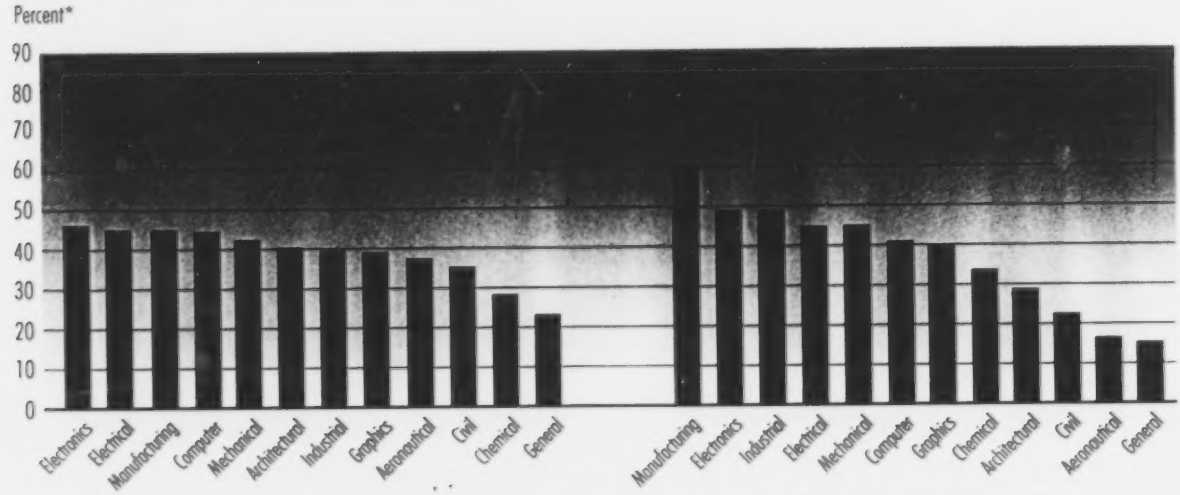
*Includes all 691 2-year colleges with a division.

**See Appendix Table A-29 for number of programs and Appendix Table A-17 for industry arrangements.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Figure 2-10

Linkages in engineering technology between 2-year colleges and local industry, by field



Numbers

Work-based programs to train students	*Aeronautical* 27	*Electrical* 151
Electronics 257	*Civil* 99	*Mechanical* 150
Electrical 154	*Chemical* 33	*Computer* 150
Manufacturing 120	*General* 49	*Graphics* 140
Computer 166		*Chemical* 38
Mechanical 143	***Arrangements to train or retrain workers***	*Architectural* 78
Architectural 111	*Manufacturing* 160	*Civil* 62
Industrial 64	*Electronics* 267	*Aeronautical* 11
Graphics 138	*Industrial* 79	*General* 32

Work-based programs to train students**
Arrangements to train or retrain workers

*Numbers in table, left, are the number of 2-year colleges with both a program and a linkage in that field. Percent is based on programs in each field.

**See Appendix Table A-29 for numbers of programs and Appendix Tables A-15 and A-17 for percent with linkages.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

There is no standard mix of engineering technology programs

The mix of engineering technology programs offered by 2-year colleges in the United States varies widely. NSF experimented with an analysis based on program offerings in these colleges to see if a "standard" mix existed in engineering technology. Two categories were developed—standard and other. Colleges with a standard mix of programs in their technology divisions

- Had programs in at least four engineering technology fields; **and also**
- Had a program in the most common field—electronics; **and also**
- Had programs in at least two of the four next most common fields (computer, graphics, electrical, or mechanical engineering).

About 40 percent of 2-year colleges with engineering technology programs met these three criteria. The remainder were labeled "other."

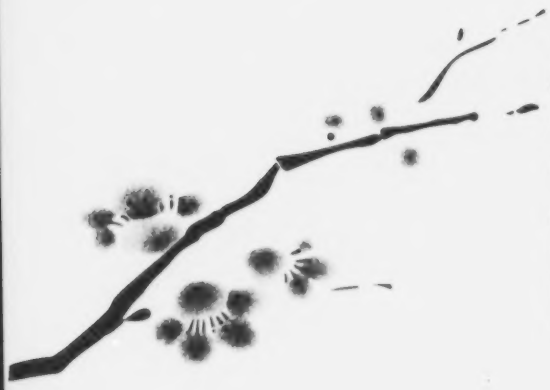
Because of the definitional criteria, these categories captured some aspect of size. Course enrollment, number of programs offered, and faculty counts were all larger in colleges with a standard engineering technology program mix. However, "standard" was not wholly explained by size: an examination of the colleges with other mixes of programs found that 120 of the 422, or 28 percent, had programs in four or more engineering technology fields. The data also showed that colleges with standard mixes also tended to be more committed to technical education, and that they had established more linkages with local industries than those with other program mixes even in fields the two categories of colleges had in common.

In short, this measure of a standard program mix of the most common fields of engineering technology was unsatisfactory in helping to differentiate among 2-year colleges. Other factors, like a college's teaching emphasis (Chapter 3) and its linkages with local schools and industry (Chapter 4), better distinguish among 2-year colleges involved in engineering technology.

42

3

TEACHING EMPHASIS IN ENGINEERING TECHNOLOGY



Administrators of engineering technology divisions reported the relative emphasis placed on teaching applied skills versus teaching fundamental science and mathematics in each of their engineering technology programs.[24] On a 5-point scale the response choices ranged from 1 (exclusive emphasis on teaching applied skills) to 3 (equal emphasis) to 5 (exclusive emphasis on teaching fundamental science and mathematics).

The mean response for all divisions was 2.7, indicating approximately equal emphasis but with a slight orientation toward applied skills (Appendix Tables A-7 and A-8).

These system-level measures, while interesting in their own right, obscure patterns and differences in teaching emphases that emerge when other factors are taken into account. In this chapter, a constructed variable called "college teaching emphasis" (see Box, next page) is used to explore some institutional differences among 2-year colleges, engineering technology programs, and other characteristics of engineering technology education in the United States.

[24] See survey questions E-1 - E-2 and E-5 in Appendix C.

College teaching emphasis

College administrators rated the relative teaching emphases of each of their engineering technology programs on a scale of 1 to 5, with "1" representing exclusively applied and "5" exclusively theoretical. NSF constructed an analytical variable from these responses as follows:

- Each college's program-level responses were summed and then divided by the number of programs offered;
- Colleges with average values below 2.5 were labeled "applied";
- Colleges with average values between 2.5 and 3.5 were labeled "balanced"; and
- Colleges with average values over 3.5 were labeled "theoretical."

About 250 2-year colleges with engineering technology divisions (36 percent) emphasize applied skills, and 70 (10 percent) emphasize fundamental science and mathematics. The remaining 375 2-year colleges–slightly more than half of those offering engineering technology–strike a balance between those two emphases.

Table 3-1

Institutional characteristics of 2-year colleges, by teaching emphasis in engineering technology

Characteristic	2-year college engineering technology divisions (N=691)	College teaching emphasis: Applied (N=247)	Balanced (N=375)	Theoretical (N=70)
Number of engineering technology programs offering certificates or associate's degrees				
Mean	5	4	4	5
Range	1-11	1-10	1-11	1-9
Mean technology course enrollment				
Per college	470	570	460	190
Per program	90	120	80	30
Mean number of technology faculty				
Per college	17	18	18	9
Per program	3	4	3	2

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

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[25] See survey question 3 in Appendix C

Two-year colleges with different teaching emphases in engineering technology rated their institutions' **commitment to technology education** somewhat differently.[25] Colleges that stress fundamental science and mathematics in their engineering technology programs are more likely than other 2-year colleges in the study to state a high commitment to preparing students for science-based technical occupations and to providing courses in science-based technical fields to students who plan to transfer into 4-year programs. In contrast, when asked about commitment to continuing education for people already employed in science-based technical fields, both "applied" and "theoretical" colleges were less likely than "balanced" colleges to rate this goal highly.

Table 3-2

2-year colleges' commitment to goals of technology education, by teaching emphasis in engineering technology

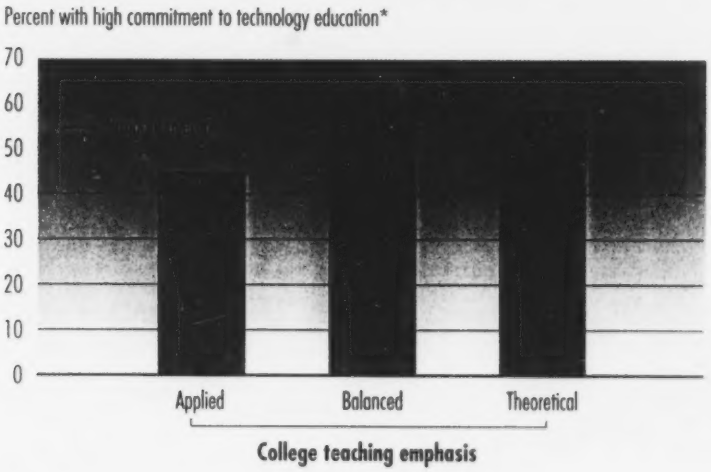
Goal	2-year college engineering technology divisions (N=691)	College teaching emphasis: Applied (N=247)	Balanced (N=375)	Theoretical (N=70)
	Percent with high commitment*			
A specific commitment to science-based technical occupations	69	64	69	86
Provision of training in entry-level technology skills for employment in science-based technical fields	77	70	81	79
Provision of continuing education for those currently employed in science-based technical fields	54	44	62	43
Provision of first and second year courses in science-based technical fields for students who wish to transfer into 4-year programs	71	64	72	92
Provision of remediation for students who are not adequately prepared for science-based technical course work at the college level	73	72	73	84

*Each goal was rated on a 5-point scale. Ratings of "4" and "5" were collapsed to represent higher than average commitment.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Figure 3-1

High commitment to technology education, by college teaching emphasis in engineering technology



*Five goals were rated on a 5-point scale. Ratings of "4" and "5" were collapsed to represent higher than average commitment. Colleges ranking each of the five goals highly were defined as high commitment. See Appendix C, question 3 for the goals. Tabulation is unpublished.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Colleges with a balanced teaching emphasis in their engineering technology programs were more likely to express an overall high college commitment to technology education[26] than were colleges with more applied or more theoretical teaching emphases. Sixty-three percent of colleges with a balanced teaching emphasis rated their commitment to technical education as high, compared to a national average of 54 percent and an average among applied colleges of 45 percent.[27]

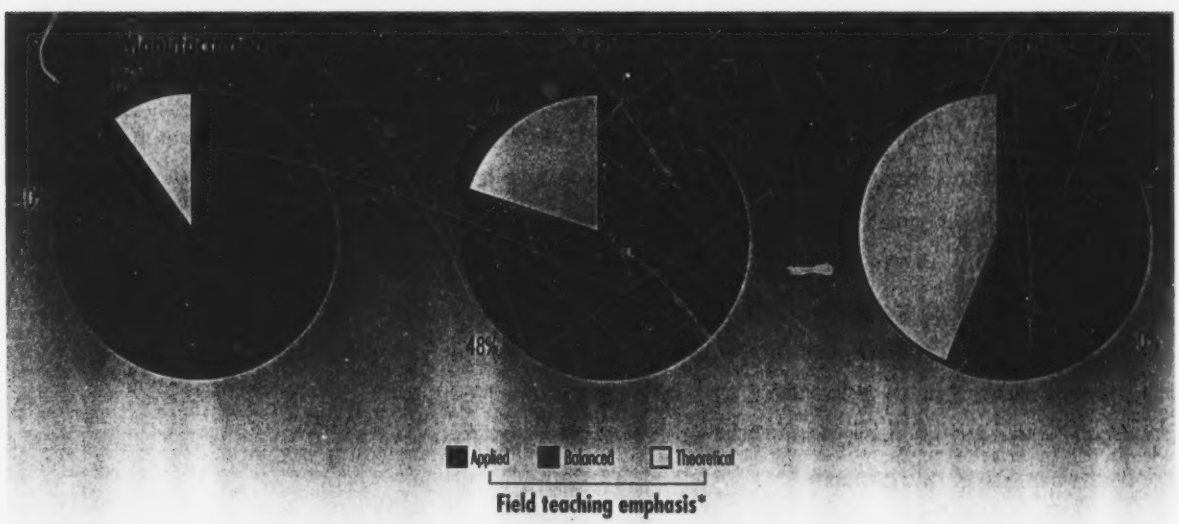
[26] For a definition of this constructed variable, see Chapter 2, page 34.

[27] Compare with the actual linkages with businesses and high schools described later in this chapter, page 51.

Two patterns of **teaching emphasis within fields** emerged. First, the dominant teaching emphasis and the mix of teaching emphases varied widely from field to field.[28] For example, 50 percent of programs offered in manufacturing engineering technology emphasize applied skills, compared with 10 percent that emphasize fundamental science and mathematics. In chemical engineering technology, the mix of teaching emphases was almost the mirror opposite: 44 percent emphasize fundamental science and math and 6 percent applied skills. In contrast to both of these fields, civil engineering technology programs across the United States are more equally divided among those emphasizing applied skills, balanced approaches, and theoretical orientations.

[28] This paragraph uses a ***field-level*** measure of teaching emphasis similar to, but not the same as, the variable discussed in the Box on page 45. For the teaching emphases in all the engineering technology fields discussed in this report, see Chapter 2, page 28 and Appendix Tables A-30 and A-8.

Figure 3-2
Teaching emphasis in selected fields of engineering technology



**Respondents reported teaching emphasis on a 5-point scale ranging from emphasis on applied skills through equal emphasis to emphasis on fundamental science and mathematics. The two values on each endpoint of the scale were collapsed to represent applied emphasis and theoretical emphasis. The center value represents a balanced emphasis. Tabulations are unpublished. See Appendix Table A-8 for mean values and Appendix Table A-30 for numbers of programs.*

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

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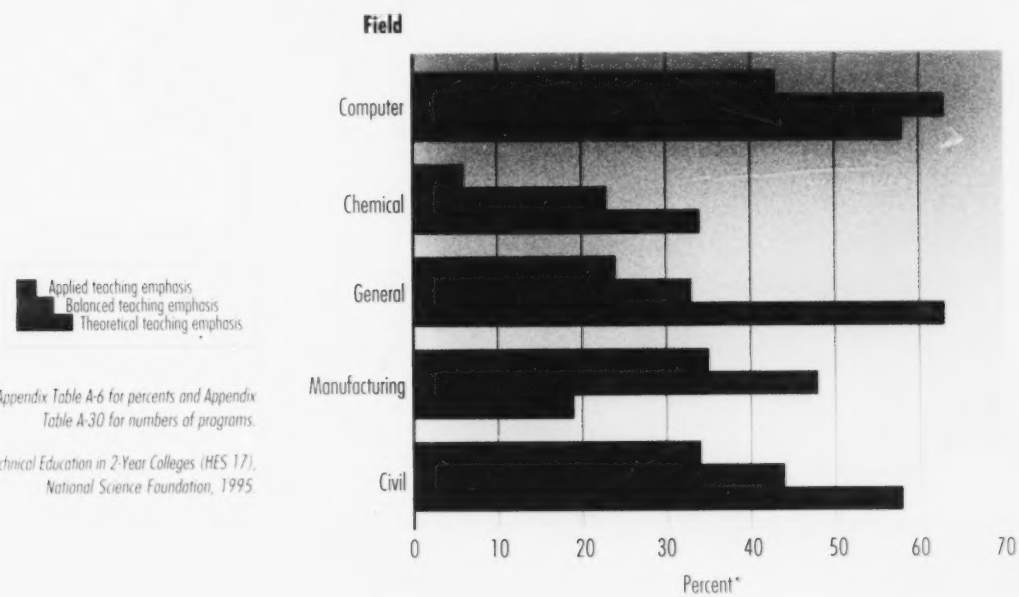
Second, the circumstances and orientation of individual 2-year colleges seem more important than some intrinsic aspect of the subject matter itself in determining teaching emphasis in engineering technology fields. As might be expected, theoretically oriented colleges are more likely than other 2-year colleges to offer programs in engineering technology fields that usually are taught with a theoretical emphasis, e.g., chemical, civil, and general engineering technology. But Appendix Table A-6 shows that colleges with theoretically oriented teaching emphases are also just as likely to offer programs in fields in which applied or balanced teaching orientations are dominant nationwide—e.g., electronics, graphics, and mechanical engineering technology—but that these colleges emphasize more theoretically oriented teaching in these fields, too. (Manufacturing engineering technology was the sole exception to this observation.)

In short, when the teaching emphases in fields of engineering technology were analyzed, variations were larger within fields than within colleges. The data from this survey suggest that 2-year colleges develop a dominant teaching emphasis that prevails throughout their engineering technology programs.

Figure 3-3

Course offerings in selected fields, by college teaching emphasis in engineering technology



*See Appendix Table A-6 for percents and Appendix Table A-30 for numbers of programs.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Two-year colleges whose teaching emphases balance fundamental science and math with applied skills in engineering technology programs are generally most likely to have **linkages with businesses and secondary schools.** However, divisions that emphasize fundamental science and math are just as likely as balanced divisions to have arrangements with 4-year colleges for transfer of credits in at least one program. In addition, when the programs in all fields in those divisions emphasizing theory are contrasted with programs in other divisions, they are more likely to have transfer arrangements (Appendix Table A-22).

Table 3-3

Linkages in engineering technology between 2-year colleges and businesses and other schools, by college teaching emphasis

Linkage	2-year college engineering technology divisions (N=691)	College teaching emphasis		
		Applied (N=247)	Balanced (N=375)	Theoretical (N=70)
	Percent			
Offer cooperative programs in technology fields	53	38	63	47
Train workers from industry in technology fields	63	57	68	58
Have tech-prep arrangements with secondary schools	62	56	58	51
Have transfer arrangements with 4-year schools	86	78	90	92

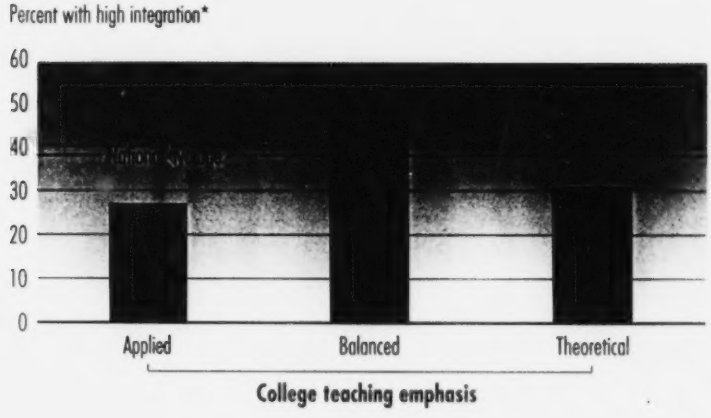
SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

[29] See Chapter 4, page 60.

NSF developed a concept of **integration with the community** that is based on three of the linkages listed in Table 3-3.[29] Forty-six percent of colleges with a balanced teaching emphasis are highly integrated, compared to the national average of 38 percent and the 27 percent of colleges with an applied teaching emphasis that are highly integrated.

Figure 3-4

Integration with the community, by 2-year college teaching emphasis in engineering technology



*Tabulations are unpublished. See Appendix Table A-2 for numbers of colleges.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Table 3-4

Enrollment trends in engineering technology, by 2-year college teaching emphasis: 1989-92

Teaching emphasis	Enrollment change			
	Declining	None	Increasing	Net increase
	Percent			
All programs (N=3,637)	23	42	34	11
College teaching emphasis				
Applied	30	40	30	0
Balanced	19	44	37	18
Theoretical	31	38	31	0

Note: Readers should note that these are ordinal, NOT ratio data. The survey questionnaire did not ask respondents to estimate magnitudes of enrollment growth or decline.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Between 1989 and 1992, course **enrollment growth** in engineering technology occurred only in programs in colleges whose teaching emphasized a balance of applied skills with fundamental science and mathematics. Nationwide, in colleges with strictly applied or theoretical teaching emphases, programs with course enrollment decreases cancelled out those with increases.[30]

[30] For a discussion of enrollment trends by field, see Chapter 2, page 29.

Administrators of engineering technology divisions emphasizing fundamental science and mathematics reported a set of **special problems** involving computers: their quality, number, and accessibility. When compared with responses from divisions emphasizing applied skills, these theoretically oriented schools are less satisfied with their computer environments.

Table 3-5

Problems in 2-year college engineering technology education, by college teaching emphasis

Aspect of instruction	2-year college engineering technology divisions (N=691)	College teaching emphasis: Applied (N=247)	College teaching emphasis: Theoretical (N=70)
	Mean rating		
Quality of computer equipment	3.7	3.9	3.1
Amount of computer equipment	3.5	3.7	2.7
Accessibility of computer equipment	3.8	3.9	3.0

NOTE: Mean rating on a scale of 1 to 5, with "1" meaning "very poor" and "5" meaning "very good."

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

4

PARTNERSHIPS IN ENGINEERING TECHNOLOGY

NSF asked 2-year college administrators about their college's **linkages to businesses**. For each field of engineering technology offered by the college, administrators were asked to specify

- Whether the institution has work-based programs involving employers and/or labor unions to train students to work in that field (e.g., cooperative education programs, school-to-apprenticeship programs, or feeder programs), and
- Whether the institution has agreements or arrangements with industry to train or retrain workers in that field.

About one-fourth (364) of the Nation's 2-year colleges had at least one cooperative arrangement with business, and about one-third (438) had some type of training or retraining agreement with industry in engineering technology fields.

Table 4-1

Linkages in engineering technology between 2-year colleges and businesses and other schools

Linkage	2-year colleges with engineering technology programs* (N=691)		Engineering technology programs (N=3,637)
	Number	Percent	
Offer cooperative programs or work-based arrangements to train students	364	53	40
Have arrangements with industry to train or retrain workers	438	63	39
Have arrangements with secondary schools to offer tech-prep programs	428	62	42
Have arrangements for student transfer to 4-year program	592	86	70

**Linkages in table are for all 2-year colleges with engineering technology awards. Linkages for colleges offering courses are given in Table 1-3, page 10.*

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

NSF also asked about **arrangements with other schools,** requesting that administrators specify:

- Whether the institution has articulation agreements or arrangements with any secondary districts or schools to offer tech-prep programs that provide at least 2 years of secondary and 2 years of postsecondary courses leading to associate's degrees or 2-year certificates in that field, and
- Whether the institution has articulation agreements or other arrangements with any 4-year colleges or college systems to facilitate the transfer of students to 4-year degree programs in that field.

Thirty-two percent (428) of all 2-year colleges, or 62 percent of colleges with engineering technology divisions, have tech-prep arrangements. Forty-five percent (592) of all 2-year colleges, or 86 percent of colleges with engineering technology divisions, have a transfer arrangement in at least one field.

The Nation's 2-year colleges are located in many different kinds of communities, some with a diversity of local businesses and industrial firms and some without. Yet notwithstanding these differing opportunities for linkages, the estimates in this report suggest that the Nation has considerable **unused capacity for linkages** between 2-year college engineering technology programs and local industry and high schools.

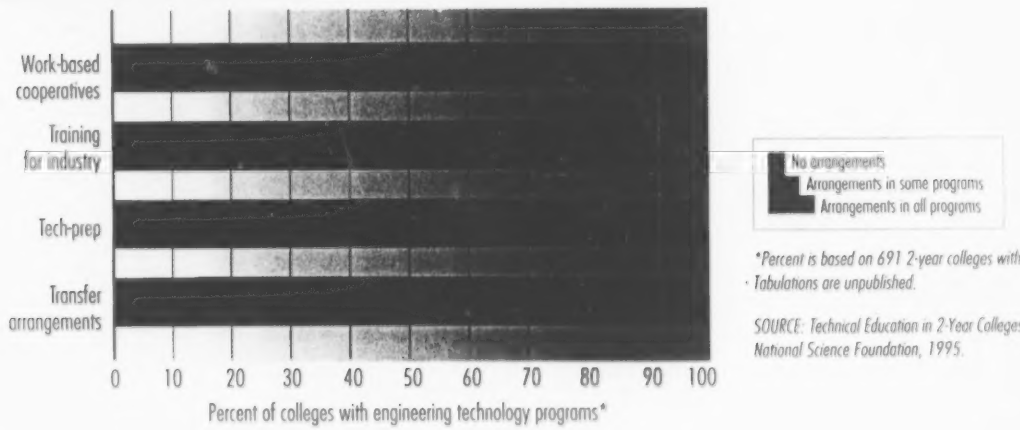
Of the 691 colleges with engineering technology divisions, about half have arrangements for transfer in all of their engineering technology programs, about 31 percent have tech-prep arrangements in all programs, and about 25 percent have training agreements with industry or work-based co-ops in all programs.

Conversely, 70 to 75 percent of 2-year colleges offering engineering technology programs have co-ops, training agreements, or tech-prep in only some or in none of their programs. At the program level, only about 40 percent of all programs have arrangements for co-ops, worker training, or tech-prep (Appendix Tables A-15 through A-20).

If it is assumed that every engineering technology division and program represents opportunities for forging linkages with local businesses for worker training and retraining, and with local high schools for school-to-work transition arrangements, then the data suggest that many such opportunities in the Nation's 2-year colleges are unrealized. Two-year colleges appear to have the infrastructure in place to allow more training of workers and students in engineering technology in cooperation with businesses, industry, and secondary schools.

Figure 4-1

2-year colleges' capacity for partnerships in engineering technology



*Percent is based on 691 2-year colleges with programs. Tabulations are unpublished.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Integration with the community

NSF developed three categories to classify colleges by their integration with the community. Three levels of integration with the community were as follows:

Low Colleges not reporting any cooperative arrangements, industry training arrangements, or tech-prep arrangements, or reporting more than five engineering technology programs but only one linkage type.

Medium Colleges reporting one or two of these types of linkages and five or fewer engineering technology programs (and not meeting the criteria above).

High Colleges reporting all three types of linkages, without regard to the number of programs at the college.

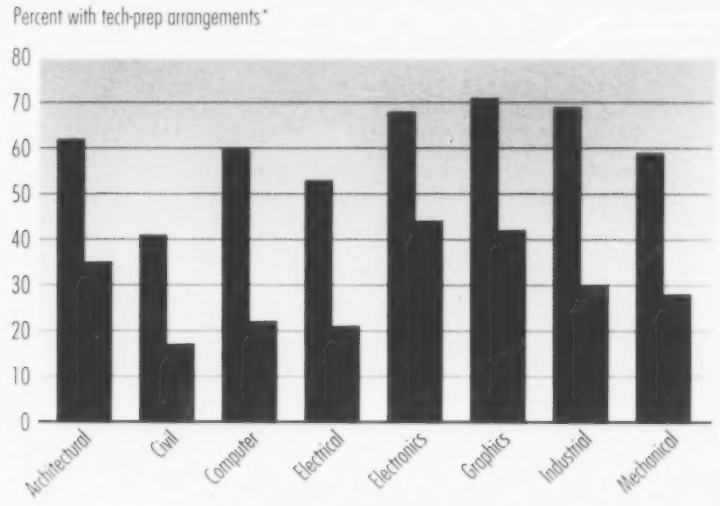
The resulting distribution of colleges was the following:

	Unweighted	*Weighted*
Low	39	163
Medium	75	267
High	85	260

Readers should note that the NSF construct "integration" is probably an underestimate of the actual degree of integration between individual 2-year colleges and their communities since only linkages in specific fields were measured. The survey instrument was not designed to measure adult literacy programs and similar programs that may be located in 2-year colleges. Special courses designed for local industry and not located in a college's formal engineering technology division may also have been missed. Also purposefully omitted from the survey were the programs in the allied health sciences located in 2-year colleges.

Figure 4-2

Articulation agreements between 2-year colleges and high schools (tech-prep) in engineering technology, by certificate award



** Tabulations are unpublished. See Appendix Table A-29 for numbers of programs.*

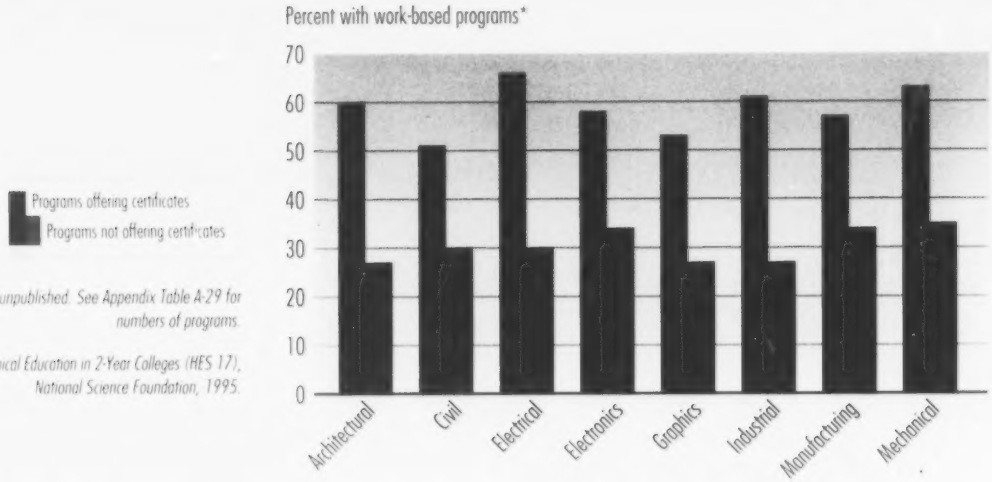
SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Unlike associate's degree programs, which contain considerable core courses usually transferrable to higher level degrees, certificate programs are tailored to the attainment of specific skills, often directly related to a local industry.

The **importance of offering certificates** to the forging of linkages between 2-year college engineering technology programs and local industry and high schools appears high. In all fields, while fewer than half of programs award certificates (Appendix Table A-9), programs in which certificates are offered are twice as likely to have tech-prep arrangements with secondary schools than programs that do not. Likewise, programs offering certificates are much more likely to have work-based cooperative training programs for students.

Figure 4-3

Work-based programs to train students in engineering technology in 2-year colleges, by certificate award



*Tabulations are unpublished. See Appendix Table A-29 for numbers of programs.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Table 4-2

Institutional characteristics of 2-year colleges in engineering technology, by level of integration with the community

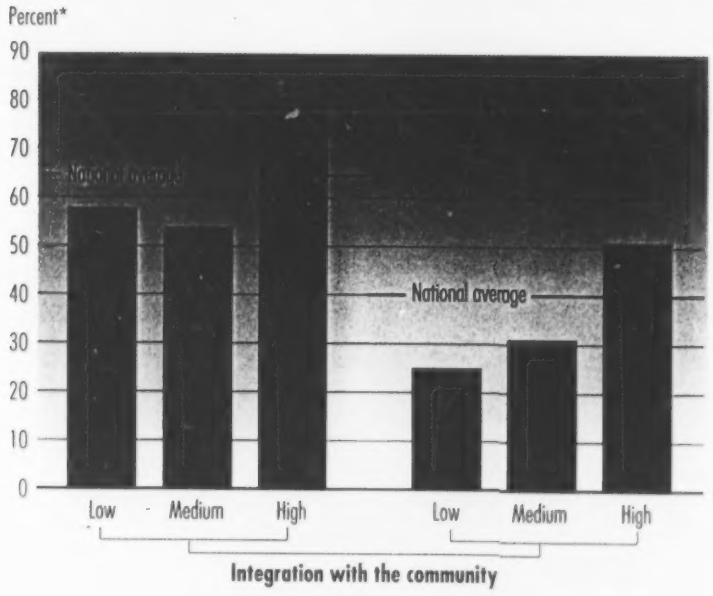
Characteristic	2-year college engineering technology divisions (N=691)	Integration with the community: High (N=260)	Medium (N=268)	Low (N=163)
Number of engineering technology programs offering certificates or associate's degrees				
Mean	5	4	4	5
Range	1-11	1-10	1-10	1-11
Mean enrollment in technology courses				
Per college	470	630	380	380
Per program	90	100	80	80
Mean number of technology faculty				
Per college	17	23	15	12
Per program	3	4	3	2

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

When three types of linkages are combined to classify colleges by their "integration with the community" (see Box, page 60), the importance of certificate programs in 2-year college training programs is also evident. About 80 percent of 2-year colleges whose engineering technology programs are highly integrated with the community offer certificates while nationally, of all 2-year engineering technology programs, 65 percent offer such certificates. About half of the engineering technology programs located in highly integrated colleges offer the certificate, compared to 23 percent in colleges with low levels of community integration.

Figure 4-4

2-year colleges and programs offering certificates in engineering technology, by college integration with the community



*Tabulations are unpublished. See Appendix Table A-29 for numbers of programs and Appendix Table A-1 for numbers of colleges.

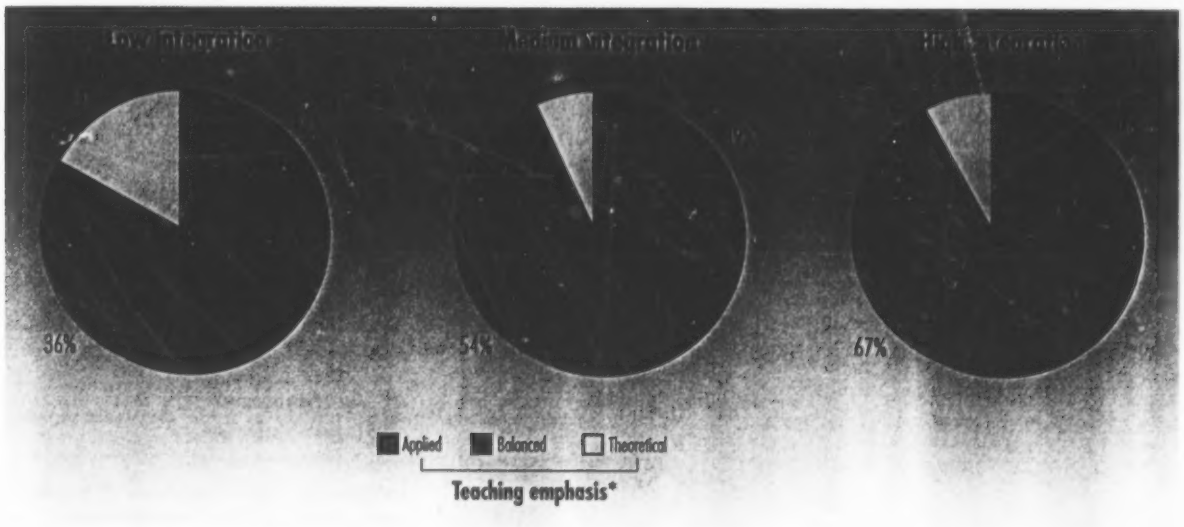
SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

[31] For a definition of the concept "college teaching emphasis," see Chapter 3, page 45.

A college's **teaching emphasis** tends to differ depending on its degree of integration with the community. Two-year colleges with linkages to businesses and secondary schools tend to emphasize a balance between applied skills and fundamental science in their engineering technology programs.[31] Colleges with relatively fewer linkages—i.e., colleges with lower levels of integration with the community—tend more often to emphasize either applied skills or fundamental science and mathematics. The greater the extent of a college's integration with the community, the more likely it will have a balanced teaching approach.

Figure 4-5

Teaching emphasis in engineering technology, by 2-year college integration with the community



SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

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Table 4-3

2-year colleges' commitment to goals of technology education, by level of integration with the community

Goal	2-year college engineering technology divisions (N=691)	Integration with the community: High (N=260)	Medium (N=268)	Low (N=163)
	Percent with high commitment*			
A specific commitment to science-based technical occupations	69	73	62	75
Provision of training in entry-level technology skills for employment in science-based technical fields	77	81	77	71
Provision of continuing education for those currently employed in science-based technical fields	54	62	57	36
Provision of first and second year courses in science-based technical fields for students who wish to transfer into 4-year programs	71	80	62	72
Provision of remediation for students who are not adequately prepared for science-based technical course work at the college level	73	79	77	59

*Each goal was rated on a 5-point scale. Ratings of "4" and "5" were collapsed to represent higher than average importance.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995

NSF was interested in how well colleges' **commitment to technology education** actually matched their programmatic integration with local businesses and secondary schools. However, since most administrators claimed high institutional commitment to technical education, differing response patterns by level of integration with the community were mostly not statistically significant.

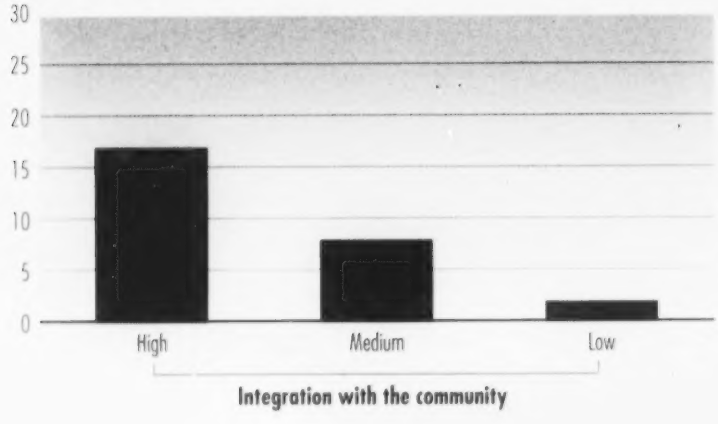
On one important facet of commitment, however, differences were significant: 2-year colleges that have a high commitment to "provision of continuing education for those currently employed in science-based technical fields" also tend to have high integration with the local community. Likewise, relatively few administrators from colleges with low integration with the community professed a high commitment to continuing technical education. The degree of integration of 2-year colleges with the community matches the stated support of their administrators for this aspect of technical education.

Enrollment growth in engineering technology courses was more extensive between 1989 and 1992 in 2-year colleges that were highly integrated with their communities. Though no causal relationship can be established, enrollment growth appears greater in colleges that have aggressively pursued the establishment of linkages with local industries and secondary schools.[34]

Figure 4-6

Enrollment increases in engineering technology in 2-year colleges, by college integration with the community: 1989-92

Percent of programs gaining net of those losing enrollment*



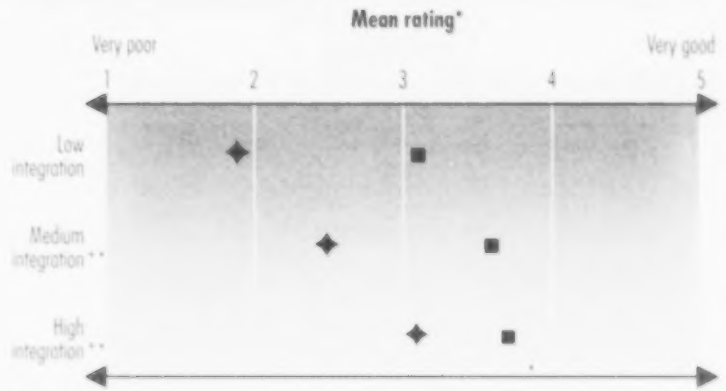
Numbers			
High	276	Low	15
Medium	99		

*See Appendix Table A-13 for percents and Appendix Table A-29 for numbers of programs.

SOURCE: Technical Education in 2-Year Colleges (HES-17), National Science Foundation, 1995.

Figure 4-7

Problems in engineering technology instruction, by college integration with the community



*See Appendix Table A-4 for mean ratings. Mean is based on 691 2-year colleges with engineering technology programs.

**Differences between medium and high are not statistically significant for opportunities for innovation in the curriculum.

SOURCE: Technical Education in 2 Year Colleges (HES 17), National Science Foundation, 1995.

NSF asked administrators at 2-year colleges involved in engineering technology about various possible problems. The responses of administrators at all types of 2-year colleges were similar (Appendix Tables A-25 and A-26), except for those from colleges with relatively low levels of integration with the community.

Administrators at colleges with low levels of integration expressed concern about **barriers to integration with the community**—namely, opportunities for

- Cooperative education and internships, and
- Innovation in the curriculum.

Determining the sources of these barriers to cooperative training programs and to innovation in curriculums will require further study. However, the findings from this study suggest that administrators are aware of their colleges' paucity of linkages with local business and industry, and that they are frustrated by it.

5

SCIENCE TECHNOLOGY IN 2-YEAR COLLEGES

Three fields of science technology—agricultural, chemical, and biotechnology—account for half of the total number of programs in 2-year college science technology divisions. The most common of these, agricultural science technology, is offered by 45 percent of colleges with science technology divisions and accounts for nearly one-fourth of science technology programs in all 2-year colleges.

Table 5-1

Science technology programs in 2-year colleges, by field

Science technology field	Programs		Colleges with divisions (N=446)
	Number	Percent of total	Percent
Total	857	100	100
Agricultural	200	23	45
Chemical	142	17	32
Biotechnology	106	12	24
Environmental	99	12	22
Food science	95	11	21
Hazardous materials	65	8	15
All other	150	18	34

NOTE: Percents may not add to 100 due to rounding.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Science technology fields

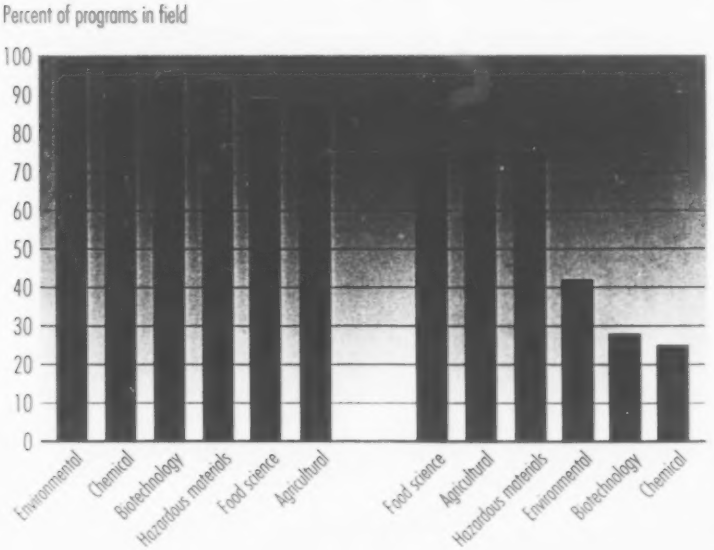
NSF asked administrators at 2-year colleges about their programs in nine fields of science technology. Respondents could also select one open-ended "other" category. The specified fields were

- Agricultural
- Biotechnology
- Chemical
- Environmental
- Food science
- Hazardous materials
- Marine science
- Materials
- Wood science

Upon review of the other science technology fields listed by respondents, NSF reclassified a number of "other" responses into the categories above and into a new category "general science laboratory technology." However, since these data were collected from a sample of 2-year colleges, sufficient responses were obtained to report estimates for only the first six fields on this list. The data obtained were also insufficient to sustain detailed analysis as in Chapters 2, 3, and 4 on engineering technology.

Patterns of programs offering **associate's degrees and certificates** in 2-year college science technology differ from patterns in engineering technology programs. First, the associate's degree is more common; between 90 and 100 percent of the programs in the six detailed fields of science technology studied award the associate's degree, compared to the 70 percent seen in some fields of engineering technology. Second, three fields (environmental, chemical, and biotechnology) are far less likely to award certificates than three other fields (hazardous materials, food science, and agricultural).

Figure 5-1
Awards offered in science technology in 2-year colleges, by field



SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Table 5-2

2-year colleges' commitment to goals of technology education

Goal	Percent with high commitment* (N=446)
A specific commitment to science-based technical occupations	69
Provision of training in entry-level technology skills for employment in science-based technical fields	75
Provision of continuing education for those currently employed in science-based technical fields	56
Provision of first and second year courses in science-based technical fields for students who wish to transfer into 4-year programs	79
Provision of remediation for students who are not adequately prepared for science-based technical coursework at the college level	75

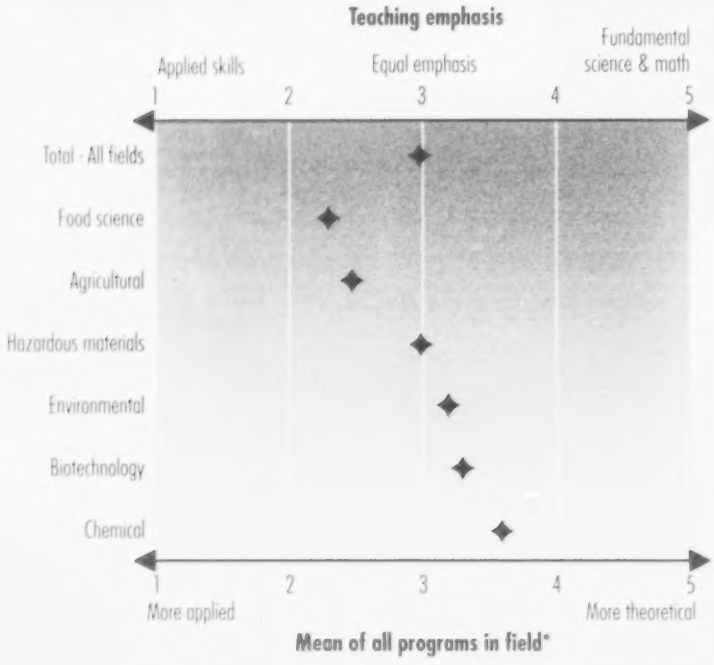
**Each goal was rated on a 5-point scale. Ratings of "4" and "5" were collapsed to represent higher than average importance. Percent is based on 446 2-year colleges with science technology programs.*

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Administrators in more than half of the 2-year colleges offering science technology report that their schools have high **commitment to technology education.** As in engineering technology, administrators report the lowest institutional support to provision of continuing education to workers.

NSF asked 2-year college administrators about their college's relative **teaching emphasis** on a scale ranging from teaching applied skills to teaching fundamental science and mathematics. The mean of all responses for science technology programs from all fields taken together, where "1" indicates more applied and "5" indicates more theoretical, was "3," or an equal emphasis. By field, food and agricultural science technologies tend to emphasize somewhat more applied skills, while environmental, biotechnology, and chemical science technology are somewhat more likely to emphasize fundamental science and mathematics.

Figure 5-2
Teaching emphasis in science technology fields in 2-year colleges



*Mean based on programs in each field

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995

About half of the 2-year colleges with science technology divisions have **linkages to the community** in the form of arrangements to train workers for industry and tech-prep arrangements with secondary schools. Seventy-two percent offer some cooperative programs, and 81 percent have arrangements to transfer credit to 4-year institutions in the same field.

But the extent of linkages varies greatly within fields of science technology, and seems to vary by teaching emphasis as well. For example, the two relatively more applied fields—agricultural and food science technology—also tend to have more arrangements with industry and businesses and more tech-prep agreements.

Only half of hazardous materials science technology programs have arrangements for course credit transfer to 4-year programs, but programs in this field are relatively more closely linked to business and industry.

Table 5-3

Linkages in science technology between 2-year colleges and businesses and other schools

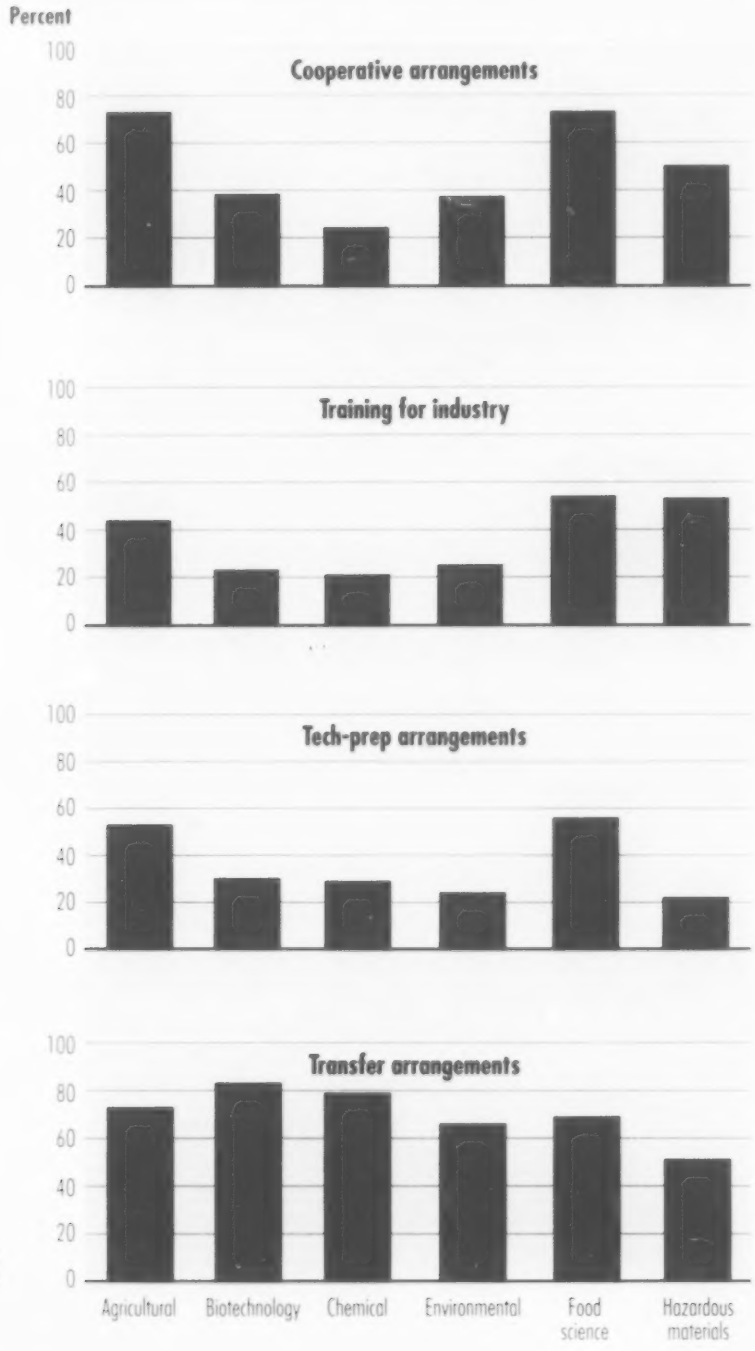
Linkage	Percent* (N=446)
Offer cooperative programs in technology fields	72
Train workers for industry in technology fields	49
Have tech-prep arrangements with secondary schools	53
Have transfer arrangements with 4-year schools	81

*Percent of 446 2-year colleges that have science technology programs.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Figure 5-3

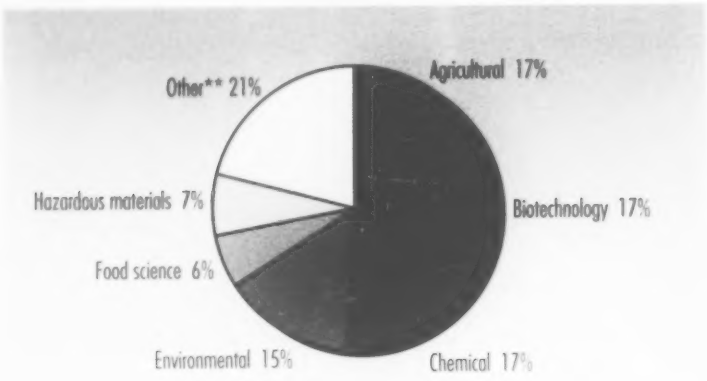
Linkages in science technology between 2-year colleges and businesses and other schools, by field



SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995

Figure 5-4

Course enrollment in science technology at 2-year colleges, by field*



	Number	Mean per college
Agricultural	15,697	83
Biotechnology	14,986	126
Chemical	15,682	92
Environmental	13,822	102
Food science	5,779	65
Hazardous materials	5,998	77
Other**	18,840	—

*Tabulations are unpublished.

**Includes science technology fields omitted from separate presentation.

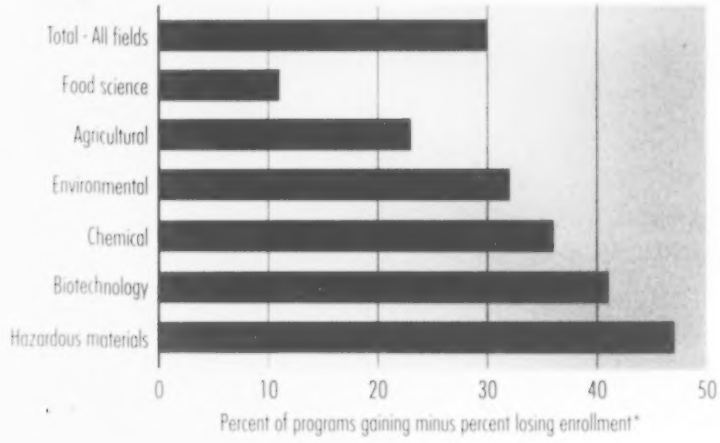
SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

The three most common programs in science technology—agricultural, chemical, and biotechnology—together account for over half of total **course enrollment** in all science technology programs in 2-year colleges nationwide.

Many programs in science technology are growing in enrollment. Between 1989 and 1992, when programs reporting decreasing enrollments are subtracted from those reporting increasing enrollments, all science technology fields show net positive enrollment growth. A net of 47 percent of programs in hazardous materials science technology and 41 percent in biotechnology increased enrollment over the 3 years.

Figure 5-5

Course enrollment trends in science technology, by field: 1989-92



Numbers

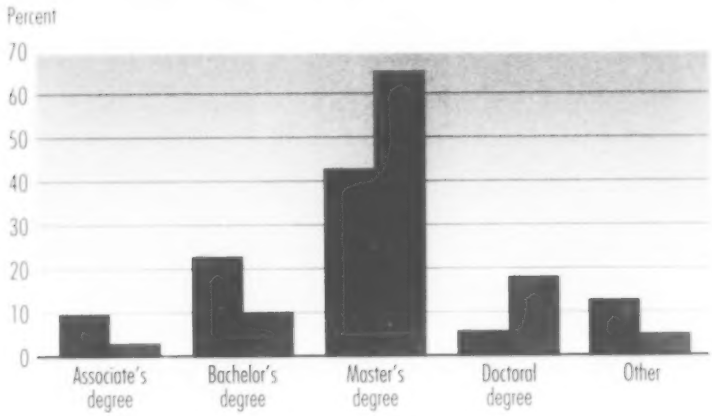
Total—All fields	296	Chemical	58
Food science	14	Biotechnology	45
Agricultural	46	Hazardous materials	39
Environmental	48		

*Tabulations are unpublished. Respondents were asked to report increases or decreases of 5 percent or more over the 3-year period. See Table 1-2 for numbers of programs.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995

Figure 5-6

Highest degree of full-time faculty in science technology and engineering technology at 2-year colleges



NOTE: "Other" includes professional engineering and other degrees.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

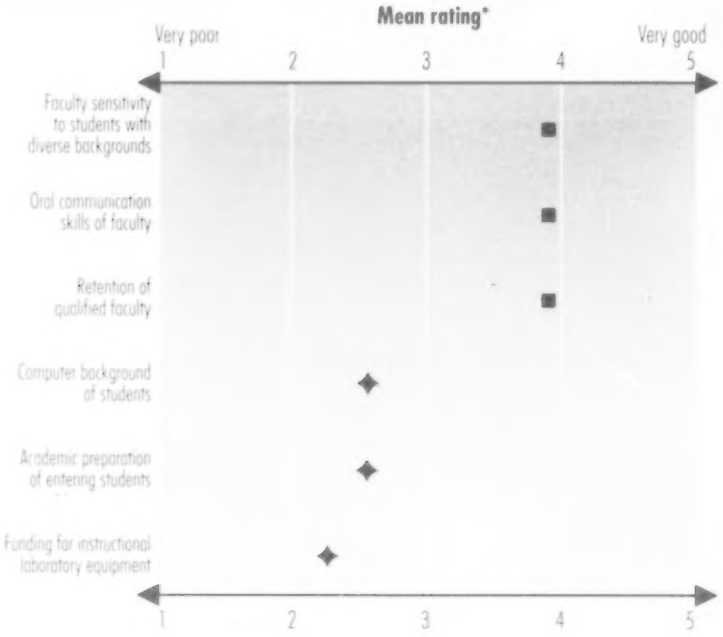
Two-year college **faculty in science technology** divisions tend to have higher levels of formal education than faculty in engineering technology. Of full-time faculty, almost one-fifth in science technology have a doctorate, compared with about 5 percent in engineering technology; about 65 percent have a master's degree compared with 43 percent in engineering technology. Ten percent of full-time faculty in science technology have a bachelor's degree, and less than 5 percent have an associate's degree.

Administrators reported **special problems** in their science technology programs, giving low ratings to the academic preparation and computer backgrounds of entering students. They were even more pessimistic about available funds for instructional laboratory equipment.

Administrators seemed to have a high regard for science technology faculty and gave them high ratings for communication skills and sensitivity to students' backgrounds.

Figure 5-7

Areas of problems and areas of quality in science technology instruction



*See Table 1-7 for mean ratings. Mean is based on 446 2-year colleges with science technology programs.

SOURCE: *Technical Education in 2-Year Colleges (HES 17)*, National Science Foundation, 1995.

APPE**A**

DETAILED DATA TABLES

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Table A-1

Degrees offered and linkages to schools and businesses of 2-year colleges in engineering technology, by program mix and integration with the community: 1993

Degrees and linkages	Total (N=691)	Engineering technology program mix: Standard (N=269)	Engineering technology program mix: Other (N=422)	Integration with the community: High (N=260)	Integration with the community: Medium (N=268)	Integration with the community: Low (N=163)
	Percent					
Degrees						
Offer certificates	65	73	60	81	54	58
Offer associate's degrees	99	100	99	100	98	100
Linkages						
Offer cooperative programs or work-based arrangements to train students	53	67	44	100	36	4
Have arrangements with industry to train or retrain workers	63	72	58	100	63	6
Have arrangements with secondary schools to offer tech-prep programs	62	71	56	100	56	10
Have arrangements for student transfer to 4-year programs	86	88	84	96	84	73

Program mix — a standard curriculum was modeled from field reports (see survey question 5 in Appendix C). Colleges with programs in at least four engineering technology fields, a program in electronics, and programs in at least two of the next four most popular fields are standard; those that do not meet all three criteria are classified as other.

Integration with the community — colleges are low integration if they have no cooperative programs, industry arrangements, or arrangements with secondary schools, or if the college has more than five programs but only one type of linkage; medium colleges have one or two types of linkages; and high integration colleges have all three (see survey question 7 in Appendix C).

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Table A-2

Degrees offered and linkages to schools and businesses of 2-year colleges, by college commitment and teaching emphasis in engineering technology: 1993

Degrees and linkages	Total (N=691)	College commitment to technology education: High (N=388)	Medium (N=195)	Low (N=108)	College teaching emphasis: Applied (N=247)	Balanced (N=375)	Theoretical (N=70)
	Percent						
Degrees							
Offer certificates	65	69	62	54	69	64	54
Offer associate's degrees	99	99	99	100	100	99	98
Linkages							
Offer cooperative programs or work-based arrangements to train students	53	61	41	42	38	63	47
Have arrangements with industry to train or retrain workers	63	63	70	53	57	68	58
Have arrangements with secondary schools to offer tech-prep programs	62	68	64	37	56	58	51
Have arrangements for student transfer to 4-year programs	86	86	87	84	78	90	92

Commitment to technology education was gauged for five goals on a 5-point scale (see survey question 3 in Appendix C). Responses were summed and split into three groups: those with 15 or fewer total points are low commitment colleges; those with between 16 and 19 points are medium commitment colleges; and those with 20 or more points are high commitment colleges.

Teaching emphasis by program was reported on a 5-point scale ranging from applied to theoretical (see survey question 6 in Appendix C). Program reports were averaged within colleges and divided into three groups. Applied colleges had average values under 2.5; balanced colleges had average values between 2.5 and 3.5; and theoretical colleges had average values over 3.5.

NOTE: Details may not sum to totals because of rounding.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Table A-3

Institutional goals of 2-year colleges in engineering technology, by program mix and integration with the community: 1993

Institutional goal	Total (N=691)	Engineering technology program mix: Standard (N=269)	Engineering technology program mix: Other (N=422)	Integration with the community: High (N=260)	Integration with the community: Medium (N=268)	Integration with the community: Low (N=163)
	Percent with high commitment*					
A specific commitment to science-based technical occupations	69	74	66	73	62	75
Training in entry-level skills for employment in science-based technical fields	77	87	71	81	77	71
Continuing education for those currently employed in science-based technical fields	54	62	48	62	57	36
First and second year courses in science-based technical fields for students who wish to transfer into 4-year programs	71	77	67	80	62	72
Remediation for students who are not adequately prepared for science-based technical coursework at the college level	73	81	69	79	77	59

*Each goal was rated on a 5-point scale. Ratings of "4" and "5" were collapsed to represent higher than average importance.

Program mix — a standard program mix was modeled from field reports (see survey question 5 in Appendix C). Colleges with programs in at least four engineering technology fields, a program in electronics, and programs in at least two of the next four most popular fields are standard; those that do not meet all three criteria are classified as other.

Integration with the community — colleges are low integration if they have no cooperative programs, industry arrangements, or arrangements with secondary schools, or if the college has more than five programs but only one type of linkage; medium colleges have one or two types of linkages, and high integration colleges have all three (see survey question 7 in Appendix C).

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Table A-4

Institutional goals of 2-year colleges in engineering technology, by college commitment and teaching emphasis: 1993

Institutional goal	Total (N=691)	College commitment to technology education: High (N=388)	Medium (N=195)	Low (N=108)	College teaching emphasis: Applied (N=247)	Balanced (N=375)	Theoretical (N=70)
	Percent with high commitment*						
A specific commitment to science-based technical occupations	69	92	57	7	64	69	86
Training in entry-level skills for employment in science-based technical fields	77	100	61	23	70	81	79
Continuing education for those currently employed in science-based technical fields	54	81	21	15	44	62	43
First and second year courses in science-based technical fields for students who wish to transfer into 4-year programs	71	90	62	20	64	72	92
Remediation for students who are not adequately prepared for science-based technical coursework at the college level	73	93	62	24	72	73	84

*Each goal was rated on a 5-point scale. Ratings of "4" and "5" were collapsed to represent higher than average importance.

Commitment to technology education was gauged for five goals on a 5-point scale (see survey question 3 in Appendix C). Responses were summed and split into three groups: those with 15 or fewer total points are low commitment colleges; those with between 16 and 19 points are medium commitment colleges; and those with 20 or more points are high commitment colleges.

Teaching emphasis by program was reported on a 5-point scale ranging from applied to theoretical (see survey question 6 in Appendix C). Program reports were averaged within colleges and divided into three groups. Applied colleges had average values under 2.5; balanced colleges had average values between 2.5 and 3.5; and theoretical colleges had average values over 3.5.

NOTE: Details may not sum to totals because of rounding.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Table A-5

Course offerings in 2-year colleges in engineering technology, by program mix and integration with the community: 1993

Engineering technology field	Total (N=691)	Engineering technology program mix: Standard (N=269)	Engineering technology program mix: Other (N=422)	Integration with the community: High (N=260)	Integration with the community: Medium (N=268)	Integration with the community: Low (N=163)
	Percent					
Electronics	83	100	72	88	83	75
Computer	56	67	48	61	52	52
Graphics	54	72	42	61	50	47
Electrical	51	70	38	53	51	47
Mechanical	51	72	37	52	48	52
Architectural	42	60	30	55	30	39
Civil	42	59	31	41	38	51
Manufacturing	40	59	28	57	32	27
General	33	39	28	38	24	39
Industrial	25	34	19	29	23	23
Chemical	18	27	12	25	11	17
Aeronautical	11	17	7	17	5	10

Program mix — a standard program mix was modeled from field reports (see survey question 5 in Appendix C). Colleges with programs in at least four engineering technology fields, a program in electronics, and programs in at least two of the next four most popular fields are standard; those that do not meet all three criteria are classified as other.

Integration with the community — colleges are low integration if they have no cooperative programs, industry arrangements, or arrangements with secondary schools, or if the college has more than five programs but only one type of linkage; medium colleges have one or two types of linkages; and high integration colleges have all three (see survey question 7 in Appendix C).

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Table A-6

Course offerings in 2-year colleges in engineering technology, by college commitment and teaching emphasis: 1993

Engineering technology field	Total (N=691)	College commitment to technology education: High (N=388)	Medium (N=195)	Low (N=108)	College teaching emphasis: Applied (N=247)	Balanced (N=375)	Theoretical (N=70)
	Percent						
Electronics	83	86	88	61	82	83	86
Computer	56	58	53	51	43	63	58
Graphics	54	61	36	59	47	59	52
Electrical	51	55	42	50	46	50	70
Mechanical	51	58	49	27	50	50	56
Architectural	42	45	41	32	41	45	25
Civil	42	48	39	26	34	44	58
Manufacturing	40	48	35	23	35	48	19
General	33	34	33	27	24	33	63
Industrial	25	32	17	15	20	29	24
Chemical	18	21	16	9	6	23	34
Aeronautical	11	15	8	2	8	13	10

Commitment to technology education was gauged for five goals on a 5-point scale (see survey question 3 in Appendix C). Responses were summed and split into three groups: those with 15 or fewer total points are low commitment colleges; those with between 16 and 19 points are medium commitment colleges; and those with 20 or more points are high commitment colleges.

Teaching emphasis by program was reported on a 5-point scale ranging from applied to theoretical (see survey question 6 in Appendix C). Program reports were averaged within colleges and divided into three groups. Applied colleges had average values under 2.5; balanced colleges had average values between 2.5 and 3.5; and theoretical colleges had average values over 3.5.

NOTE: Details may not sum to totals because of rounding.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Table A-7

Teaching emphasis in engineering technology fields of 2-year colleges, by program mix and integration with the community: 1993*

Engineering technology field	Total	Engineering technology program mix		Integration with the community		
		Standard	Other	High	Medium	Low
	Mean					
All colleges	2.7	2.7	2.6	2.7	2.6	2.7
All programs**	2.7	2.7	2.7	2.7	2.6	2.9
Electronics	2.6	2.7	2.6	2.7	2.5	2.7
Computer	2.6	2.8	2.5	2.8	2.7	—
Graphics	2.5	2.5	2.5	2.6	2.4	2.6
Electrical	2.7	2.8	2.6	2.7	2.7	—
Mechanical	2.8	2.8	2.8	2.8	2.7	—
Architectural	2.5	2.5	2.6	2.5	2.6	—
Civil	2.9	2.9	2.9	2.9	2.8	3.2
Manufacturing	2.5	2.5	2.5	2.6	2.4	—
General	3.4	3.4	3.4	3.5	2.7	—
Industrial	2.7	2.7	2.7	2.5	2.5	—
Chemical	3.6	3.5	—	—	—	—
Aeronautical	2.5	—	—	—	—	—

* *Teaching emphasis was measured on a 5-point scale, with a score of "1" designating an applied emphasis and a score of "5" designating a theoretical emphasis.*

** *Figures for all programs combine responses from all fields including those omitted from separate presentation.*

— *Insufficient cases for estimation.*

Program mix — a standard program mix was modeled from field reports (see survey question 5 in Appendix C). Colleges with programs in at least four engineering technology fields, a program in electronics, and programs in at least two of the next four most popular fields are standard; those that do not meet all three criteria are classified as other.

Integration with the community — colleges are low integration if they have no cooperative programs, industry arrangements, or arrangements with secondary schools, or if the college has more than five programs but only one type of linkage; medium colleges have one or two types of linkages; and high integration colleges have all three (see survey question 7 in Appendix C).

NOTE: Numbers of programs presented in Table A-29.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Table A-8

Teaching emphasis in engineering technology fields of 2-year colleges, by college commitment: 1993*

Engineering technology field	Total	College commitment to technology education: High	Medium	Low
	Mean			
All colleges	2.7	2.7	2.6	2.5
All programs**	2.7	2.8	2.8	2.6
Electronics	2.6	2.7	2.6	—
Computer	2.6	2.7	2.5	—
Graphics	2.5	2.5	2.6	—
Electrical	2.7	2.7	2.8	—
Mechanical	2.8	2.8	2.7	—
Architectural	2.5	2.6	2.4	—
Civil	2.9	2.9	3.1	—
Manufacturing	2.5	2.4	2.7	—
General	3.4	3.3	4.0	—
Industrial	2.7	2.8	—	—
Chemical	3.6	3.4	—	—
Aeronautical	2.5	2.5	—	—

* *Teaching emphasis was measured on a 5-point scale, with a score of "1" designating an applied emphasis and a score of "5" designating a theoretical emphasis.*

** *Figures for all programs combine responses from all fields including those omitted from separate presentation.*

— *Insufficient cases for estimation.*

Commitment to technology education was gauged for five goals on a 5-point scale (see survey question 3 in Appendix C). Responses were summed and split into three groups: those with 15 or fewer total points are low commitment colleges; those with between 16 and 19 points are medium commitment colleges, and those with 20 or more points are high commitment colleges.

NOTE: Numbers of programs presented in Table A-30.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Table A-9

Degrees awarded in engineering technology fields by 2-year colleges, by program mix and integration with the community: 1993

Engineering technology field	Total	Engineering technology program mix		Integration with the community		
		Standard	Other	High	Medium	Low
	Percent					
All colleges						
Certificate	65	73	60	81	54	58
Associate's degree	99	100	99	100	98	100
All programs*						
Certificate	38	40	35	50	31	23
Associate's degree	79	88	69	80	79	77
Electronics						
Certificate	42	43	41	56	29	41
Associate's degree	90	99	81	93	87	90
Computer						
Certificate	48	45	50	57	47	—
Associate's degree	85	99	72	87	80	—
Graphics						
Certificate	45	54	36	62	35	26
Associate's degree	75	82	66	82	58	91
Electrical						
Certificate	42	48	35	65	29	—
Associate's degree	76	92	58	71	81	—
Mechanical						
Certificate	27	31	22	38	25	—
Associate's degree	80	92	65	90	81	—
Architectural						
Certificate	40	44	33	54	35	—
Associate's degree	79	78	80	78	88	—
Civil						
Certificate	28	28	27	35	24	23
Associate's degree	77	88	64	72	87	71
Manufacturing						
Certificate	49	52	45	57	38	—
Associate's degree	80	84	75	82	77	—
General						
Certificate	27	25	28	26	20	—
Associate's degree	78	84	73	68	85	—
Industrial						
Certificate	38	45	30	60	26	—
Associate's degree	68	80	56	81	60	—
Chemical						
Certificate	18	12	—	—	—	—
Associate's degree	72	73	—	—	—	—
Aeronautical						
Certificate	39	—	—	—	—	—
Associate's degree	68	—	—	—	—	—

* *Figures for all programs combine responses from all fields including those omitted from separate presentation.*
— *Insufficient cases for estimation.*

Program mix — a standard program mix was modeled from field reports (see survey question 5 in Appendix C). Colleges with programs in at least four engineering technology fields, a program in electronics, and programs in at least two of the next four most popular fields are standard; those that do not meet all three criteria are classified as other.

Integration with the community — colleges are low integration if they have no cooperative programs, industry arrangements, or arrangements with secondary schools, or if the college has more than five programs but only one type of linkage; medium colleges have one or two types of linkages; and high integration colleges have all three (see survey question 7 in Appendix C).

NOTE: Numbers of programs presented in Table A-29.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Table A-10

Degrees awarded in engineering technology fields by 2-year colleges, by college commitment and teaching emphasis: 1993

Engineering technology field	Total	College commitment to technology education			College teaching emphasis		
		High	Medium	Low	Applied	Balanced	Theoretical
	Percent						
All colleges							
Certificate	65	69	62	54	69	65	54
Associate's degree	99	99	99	100	100	99	98
All programs*							
Certificate	38	40	36	31	42	39	18
Associate's degree	79	79	82	75	83	75	90
Electronics							
Certificate	42	39	47	—	40	42	—
Associate's degree	90	88	98	—	96	86	—
Computer							
Certificate	48	54	38	—	48	52	—
Associate's degree	85	84	83	—	81	84	—
Graphics							
Certificate	45	48	50	—	55	43	—
Associate's degree	75	78	81	—	79	69	—
Electrical							
Certificate	42	45	40	—	51	41	—
Associate's degree	76	74	80	—	74	75	—
Mechanical							
Certificate	27	30	19	—	28	31	—
Associate's degree	80	85	70	—	85	77	—
Architectural							
Certificate	40	36	50	—	45	39	—
Associate's degree	79	75	78	—	76	78	—
Civil							
Certificate	28	33	21	—	41	22	—
Associate's degree	77	80	74	—	90	70	—
Manufacturing							
Certificate	49	56	40	—	52	45	—
Associate's degree	80	73	96	—	89	74	—
General							
Certificate	27	29	8	—	—	34	—
Associate's degree	78	80	73	—	—	71	—
Industrial							
Certificate	38	45	—	—	—	42	—
Associate's degree	68	71	—	—	—	67	—
Chemical							
Certificate	18	16	—	—	—	20	—
Associate's degree	72	69	—	—	—	64	—
Aeronautical							
Certificate	39	32	—	—	—		—
Associate's degree	68	75	—	—	—	—	—

* Figures for all programs combine responses from all fields including those omitted from separate presentation.
— Insufficient cases for estimation.

Commitment to technology education was gauged for five goals on a 5-point scale (see survey question 3 in Appendix C). Responses were summed and split into three groups: those with 15 or fewer total points are low commitment colleges; those with between 16 and 19 points are medium commitment colleges; and those with 20 or more points are high commitment colleges.

Teaching emphasis by program was reported on a 5-point scale ranging from applied to theoretical (see survey question 6 in Appendix C). Program reports were averaged within colleges and divided into three groups. Applied colleges had average values under 2.5; balanced colleges had average values between 2.5 and 3.5; and theoretical colleges had average values over 3.5.

NOTE: Numbers of programs presented in Table A-30.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Table A-11

Course enrollments in engineering technology fields in 2-year colleges, by program mix and integration with the community: 1993

Engineering technology field	Total	Engineering technology program mix		Integration with the community		
		Standard	Other	High	Medium	Low
Total						
Total number	324,400	186,530	137,870	162,770	99,820	61,830
Mean number per college	470	700	330	630	380	380
Mean number per program*	90	100	80	100	80	80
Electronics						
Total number	66,500	29,510	36,990	35,500	17,740	13,260
Mean number	120	120	130	160	180	110
Computer						
Total number	52,920	30,900	22,020	23,390	18,500	—
Mean number	160	200	120	180	150	—
Graphics						
Total number	32,480	22,440	10,040	17,460	8,874	6,160
Mean number	100	120	60	120	70	90
Electrical						
Total number	28,500	17,740	10,760	13,760	8,930	—
Mean number	100	110	80	140	70	—
Mechanical						
Total number	20,980	16,090	4,880	8,710	8,880	—
Mean number	70	90	40	80	80	—
Architectural						
Total number	26,900	15,390	11,510	15,840	5,790	—
Mean number	110	100	120	130	80	—
Civil						
Total number	17,800	10,490	7,310	7,900	6,590	3,310
Mean number	70	80	60	100	70	40
Manufacturing						
Total number	17,070	11,160	5,910	9,780	3,720	—
Mean number	70	80	60	80	50	—
General						
Total number	19,750	13,490	6,250	12,130	2,430	—
Mean number	110	160	60	150	40	—
Industrial						
Total number	9,050	4,220	4,830	4,850	2,630	—
Mean number	60	60	70	80	50	—
Chemical						
Total number	5,020	2,730	—	—	—	—
Mean number	50	50	—	—	—	—
Aeronautical						
Total number	6,130	—	—	—	—	—
Mean number	100	—	—	—	—	—

* Figures for all programs combine responses from all fields including those omitted from separate presentation.
— Insufficient cases for estimation.

Program mix — a standard program mix was modeled from field reports (see survey question 5 in Appendix C). Colleges with programs in at least four engineering technology fields, a program in electronics, and programs in at least two of the next four most popular fields are standard; those that do not meet all three criteria are classified as other.

Integration with the community — colleges are low integration if they have no cooperative programs, industry arrangements, or arrangements with secondary schools, or if the college has more than five programs but only one type of linkage; medium colleges have one or two types of linkages; and high integration colleges have all three (see survey question 7 in Appendix C).

NOTE: Numbers of programs presented in Table A-29. Details may not sum to totals because of rounding.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Table A-12

Course enrollments in engineering technology fields in 2-year colleges, by college commitment and teaching emphasis: 1993

Engineering technology field	Total	College commitment to technology education			College teaching emphasis		
		High	Medium	Low	Applied	Balanced	Theoretical
Total							
Total number	324,400	218,300	70,780	35,330	139,600	172,000	12,810
Mean number per college	470	570	365	320	570	460	190
Mean number per program*	90	100	80	80	120	80	30
Electronics							
Total number	66,500	43,270	17,730	—	25,530	38,090	—
Mean number	120	140	110	—	130	130	—
Computer							
Total number	52,920	29,160	13,220	—	21,720	30,640	—
Mean number	160	150	140	—	220	150	—
Graphics							
Total number	32,480	22,070	5,930	—	15,410	14,830	—
Mean number	100	100	90	—	140	80	—
Electrical							
Total number	28,500	22,400	4,400	—	14,470	12,930	—
Mean	100	130	60	—	130	90	—
Mechanical							
Total number	20,980	15,190	4,860	—	8,910	11,170	—
Mean number	70	80	50	—	70	80	—
Architectural							
Total number	26,900	17,210	7,270	—	11,470	14,590	—
Mean number	110	120	100	—	120	110	—
Civil							
Total number	17,800	10,970	4,640	—	7,370	9,460	—
Mean number	70	70	70	—	90	70	—
Manufacturing							
Total number	17,070	12,870	2,900	—	7,780	9,190	—
Mean number	70	80	50	—	90	60	—
General							
Total number	19,750	14,300	4,350	—	—	13,160	—
Mean number	110	140	70	—	—	140	—
Industrial							
Total number	9,050	7,000	—	—	—	5,970	—
Mean number	60	70	—	—	—	70	—
Chemical							
Total number	5,020	3,350	—	—	—	4,630	—
Mean number	50	50	—	—	—	70	—
Aeronautical							
Total number	6,130	3,990	—	—	—	1,430	—
Mean number	100	90	—	—	—	40	—

* Figures for all programs combine responses from all fields including those omitted from separate presentation.
— Insufficient cases for estimation.

Commitment to technology education was gauged for five goals on a 5-point scale (see survey question 3 in Appendix C). Responses were summed and split into three groups: those with 15 or fewer total points are low commitment colleges, those with between 16 and 19 points are medium commitment colleges, and those with 20 or more points are high commitment colleges.

Teaching emphasis by program was reported on a 5-point scale ranging from applied to theoretical (see survey question 6 in Appendix C). Program reports were averaged within colleges and divided into three groups. Applied colleges had average values under 2.5; balanced colleges had average values between 2.5 and 3.5; and theoretical colleges had average values over 3.5.

NOTE: Numbers of programs presented in Table A-30. Details may not sum to totals because of rounding.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Table A-13

Change in course enrollments* in engineering technology fields in 2-year colleges, by program mix and integration with the community: 1993

Engineering technology field	Total	Engineering technology program mix		Integration with the community		
		Standard	Other	High	Medium	Low
	Percent					
All programs**	11	19	4	17	8	2
Electronics	1	6	−4	14	−9	−6
Computer	36	28	42	31	42	—
Graphics	27	26	28	35	17	27
Electrical	13	21	6	15	2	—
Mechanical	−3	12	22	5	14	—
Architectural	0	17	−20	8	16	—
Civil	7	26	−15	10	23	−17
Manufacturing	12	4	11	12	19	—
General	13	12	12	8	19	—
Industrial	4	6	3	26	−2	—
Chemical	14	36	—	—	—	—
Aeronautical	18	—	—	—	—	—

* *Programs gaining in enrollment minus those losing enrollment.*

** *Figures for all programs combine responses from all fields including those omitted from separate presentation.*

— *Insufficient cases for estimation.*

Program mix — a standard program mix was modeled from field reports (see survey question 5 in Appendix C). Colleges with programs in at least four engineering technology fields, a program in electronics, and programs in at least two of the next four most popular fields are standard; those that do not meet all three criteria are classified as other.

Integration with the community — colleges are low integration if they have no cooperative programs, industry arrangements, or arrangements with secondary schools, or if the college has more than five programs but only one type of linkage; medium colleges have one or two types of linkages; and high integration colleges have all three (see survey question 7 in Appendix C).

NOTE: Numbers of programs presented in Table A-29.

SOURCE: Technical Education in 2-Year Colleges (HES'17), National Science Foundation, 1995.

Table A-14

Change in course enrollments in engineering technology fields in 2-year colleges, by college commitment and teaching emphasis: 1993*

Engineering technology field	Total	College commitment to technology education			College teaching emphasis		
		High	Medium	Low	Applied	Balanced	Theoretical
	Percent						
All programs**	11	11	18	2	0	18	0
Electronics	1	0	5	—	–5	0	—
Computer	36	44	23	—	22	39	—
Graphics	27	33	30	—	2	38	—
Electrical	13	3	41	—	14	15	—
Mechanical	–3	4	–17	—	–20	12	—
Architectural	0	–4	18	—	–15	9	—
Civil	7	1	19	—	–11	22	—
Manufacturing	12	7	39	—	8	14	—
General	13	15	15	—	—	19	—
Industrial	4	4	—	—	—	18	—
Chemical	14	20	—	—	—	19	—
Aeronautical	18	20	—	—	—	—	—

* *Programs gaining in enrollment minus those losing enrollment.*

** *Figures for all programs combine responses from all fields including those omitted from separate presentation.*

— *Insufficient cases for estimation.*

Commitment to technology education was gauged for five goals on a 5-point scale (see survey question 3 in Appendix C). Responses were summed and split into three groups: those with 15 or fewer total points are low commitment colleges; those with between 16 and 19 points are medium commitment colleges; and those with 20 or more points are high commitment colleges.

Teaching emphasis by program was reported on a 5-point scale ranging from applied to theoretical (see survey question 6 in Appendix C). Program reports were averaged within colleges and divided into three groups. Applied colleges had average values under 2.5; balanced colleges had average values between 2.5 and 3.5; and theoretical colleges had average values over 3.5.

NOTE: Numbers of programs presented in Table A-30.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Table A-15

Cooperative programs or other work-based programs in engineering technology fields in 2-year colleges, by program mix and integration with the community: 1993

Engineering technology field	Total	Engineering technology program mix		Integration with the community		
		Standard	Other	High	Medium	Low
	Percent					
All colleges	53	67	44	100	36	4
All programs*	40	48	31	68	28	1
Electronics	46	57	35	80	30	6
Computer	44	52	38	74	36	—
Graphics	39	48	28	68	24	0
Electrical	45	48	41	84	29	—
Mechanical	42	52	30	68	43	—
Architectural	40	50	27	59	33	—
Civil	35	37	34	62	34	0
Manufacturing	45	53	34	75	12	—
General	23	31	15	33	27	—
Industrial	39	48	30	70	19	—
Chemical	28	33	—	—	—	—
Aeronautical	37	—	—	—	—	—

* *Figures for all programs combine responses from all fields including those omitted from separate presentation.*

— *Insufficient cases for estimation.*

Program mix — a standard program mix was modeled from field reports (see survey question 5 in Appendix C). Colleges with programs in at least four engineering technology fields, a program in electronics, and programs in at least two of the next four most popular fields are standard; those that do not meet all three criteria are classified as other.

Integration with the community — colleges are low integration if they have no cooperative programs, industry arrangements, or arrangements with secondary schools, or if the college has more than five programs but only one type of linkage; medium colleges have one or two types of linkages; and high integration colleges have all three (see survey question 7 in Appendix C).

NOTE: Numbers of programs presented in Table A-29.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Table A-16

Cooperative programs or other work-based programs in engineering technology fields in 2-year colleges, by college commitment and teaching emphasis: 1993

Engineering technology field	Total	College commitment to technology education			College teaching emphasis		
		High	Medium	Low	Applied	Balanced	Theoretical
	Percent						
All colleges	53	61	41	42	38	63	47
All programs*	40	43	35	33	35	46	22
Electronics	46	54	33	—	37	51	—
Computer	44	48	38	—	37	53	—
Graphics	39	44	31	—	25	45	—
Electrical	45	53	29	—	31	59	—
Mechanical	42	48	35	—	39	50	—
Architectural	40	36	54	—	41	38	—
Civil	35	33	41	—	33	41	—
Manufacturing	45	42	55	—	49	42	—
General	23	25	17	—	—	30	—
Industrial	39	40	—	—	—	41	—
Chemical	28	43	—	—	—	38	—
Aeronautical	37	46	—	—	—	—	—

* *Figures for all programs combine responses from all fields including those omitted from separate presentation.*
— *Insufficient cases for estimation.*

Commitment to technology education was gauged for five goals on a 5-point scale (see survey question 3 in Appendix C). Responses were summed and split into three groups: those with 15 or fewer total points are low commitment colleges; those with between 16 and 19 points are medium commitment colleges; and those with 20 or more points are high commitment colleges.

Teaching emphasis by program was reported on a 5-point scale ranging from applied to theoretical (see survey question 6 in Appendix C). Program reports were averaged within colleges and divided into three groups. Applied colleges had average values under 2.5; balanced colleges had average values between 2.5 and 3.5; and theoretical colleges had average values over 3.5.

NOTE: Numbers of programs presented in Table A-30.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Table A-17

Arrangements of 2-year colleges with industry to train or retrain workers in engineering technology fields, by program mix and integration with the community: 1993

Engineering technology field	Total	Engineering technology program mix		Integration with the community		
		Standard	Other	High	Medium	Low
	Percent					
All colleges	63	72	58	100	63	6
All programs*	39	41	37	60	36	3
Electronics	48	55	42	72	47	1
Computer	40	48	34	59	35	—
Graphics	39	47	31	62	32	2
Electrical	44	45	43	69	42	—
Mechanical	44	36	54	67	47	—
Architectural	28	25	32	46	17	—
Civil	22	19	26	35	24	2
Manufacturing	60	60	61	87	37	—
General	15	19	11	27	9	—
Industrial	48	49	48	79	31	—
Chemical	33	31	—	—	—	—
Aeronautical	16	—	—	—	—	—

* *Figures for all programs combine responses from all fields including those omitted from separate presentation.*
— *Insufficient cases for estimation.*

Program mix — a standard program mix was modeled from field reports (see survey question 5 in Appendix C). Colleges with programs in at least four engineering technology fields, a program in electronics, and programs in at least two of the next four most popular fields are standard; those that do not meet all three criteria are classified as other.

Integration with the community — colleges are low integration if they have no cooperative programs, industry arrangements, or arrangements with secondary schools, or if the college has more than five programs but only one type of linkage; medium colleges have one or two types of linkages; and high integration colleges have all three (see survey question 7 in Appendix C).

NOTE: Numbers of programs presented in Table A-29.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Table A-18

Arrangements of 2-year colleges with industry to train or retrain workers in engineering technology fields, by college commitment and teaching emphasis: 1993

Engineering technology field	Total	College commitment to technology education			College teaching emphasis		
		High	Medium	Low	Applied	Balanced	Theoretical
	Percent						
All colleges	63	63	70	53	57	68	58
All programs*	39	40	42	30	39	41	26
Electronics	48	47	52	—	51	48	—
Computer	40	40	45	—	36	42	—
Graphics	39	42	56	—	35	39	—
Electrical	44	50	47	—	39	53	—
Mechanical	44	41	46	—	39	53	—
Architectural	28	23	43	—	32	25	—
Civil	22	26	18	—	23	23	—
Manufacturing	60	62	54	—	61	61	—
General	15	16	13	—	—	17	—
Industrial	48	50	—	—	—	49	—
Chemical	33	39	—	—	—	42	—
Aeronautical	16	18	—	—	—	—	—

* *Figures for all programs combine responses from all fields including those omitted from separate presentation.*
— *Insufficient cases for estimation.*

Commitment to technology education was gauged for five goals on a 5-point scale (see survey question 3 in Appendix C). Responses were summed and split into three groups: those with 15 or fewer total points are low commitment colleges; those with between 16 and 19 points are medium commitment colleges; and those with 20 or more points are high commitment colleges.

Teaching emphasis by program was reported on a 5-point scale ranging from applied to theoretical (see survey question 6 in Appendix C). Program reports were averaged within colleges and divided into three groups. Applied colleges had average values under 2.5; balanced colleges had average values between 2.5 and 3.5; and theoretical colleges had average values over 3.5.

NOTE: Numbers of programs presented in Table A-30.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Table A-19

Tech-prep arrangements in engineering technology fields in 2-year colleges, by program mix and integration with the community: 1993

Engineering technology field	Total	Engineering technology program mix		Integration with the community		
		Standard	Other	High	Medium	Low
	Percent					
All colleges	62	71	56	100	56	10
All programs*	42	42	41	67	31	7
Electronics	54	55	54	86	46	9
Computer	40	37	42	62	37	—
Graphics	54	65	43	83	44	8
Electrical	34	40	27	61	21	—
Mechanical	36	36	36	62	29	—
Architectural	48	48	47	73	23	—
Civil	24	21	27	47	12	7
Manufacturing	52	45	62	71	39	—
General	31	25	36	45	31	—
Industrial	42	33	52	80	13	—
Chemical	32	30	34	39	29	—
Aeronautical	44	47	—	—	—	—

** Figures for all programs combine responses from all fields including those omitted from separate presentation.*
— Insufficient cases for estimation.

Program mix — a standard program mix was modeled from field reports (see survey question 5 in Appendix C). Colleges with programs in at least four engineering technology fields, a program in electronics, and programs in at least two of the next four most popular fields are standard; those that do not meet all three criteria are classified as other.

Integration with the community — colleges are low integration if they have no cooperative programs, industry arrangements, or arrangements with secondary schools, or if the college has more than five programs but only one type of linkage; medium colleges have one or two types of linkages; and high integration colleges have all three (see survey question 7 in Appendix C).

NOTE: Numbers of programs presented in Table A-29.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Table A-20

Tech-prep arrangements in engineering technology fields in 2-year colleges, by college commitment and teaching emphasis: 1993

Engineering technology field	Total	College commitment to technology education			College teaching emphasis		
		High	Medium	Low	Applied	Balanced	Theoretical
	Percent						
All colleges	62	68	64	37	56	58	51
All programs*	42	44	42	27	38	46	29
Electronics	54	53	61	—	44	62	—
Computer	40	46	31	—	38	44	—
Graphics	54	60	65	—	44	61	—
Electrical	34	36	44	—	25	37	—
Mechanical	36	39	35	—	31	40	—
Architectural	48	55	43	—	44	49	—
Civil	24	26	23	—	22	30	—
Manufacturing	52	52	56	—	44	57	—
General	31	30	29	—	—	32	—
Industrial	42	46	—	—	—	46	—
Chemical	32	38	—	—	—	33	—
Aeronautical	44	51	—	—	—	—	—

* *Figures for all programs combine responses from all fields including those omitted from separate presentation.*
— *Insufficient cases for estimation.*

Commitment to technology education was gauged for five goals on a 5-point scale (see survey question 3 in Appendix C). Responses were summed and split into three groups: those with 15 or fewer total points are low commitment colleges; those with between 16 and 19 points are medium commitment colleges; and those with 20 or more points are high commitment colleges.

Teaching emphasis by program was reported on a 5-point scale ranging from applied to theoretical (see survey question 6 in Appendix C). Program reports were averaged within colleges and divided into three groups. Applied colleges had average values under 2.5; balanced colleges had average values between 2.5 and 3.5; and theoretical colleges had average values over 3.5.

NOTE: Numbers of programs presented in Table A-30.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Table A-21

Arrangements for student transfer from 2-year colleges to 4-year programs in engineering technology fields, by program mix and integration with the community: 1993

Engineering technology field	Total	Engineering technology program mix		Integration with the community		
		Standard	Other	High	Medium	Low
	Percent					
All colleges	86	88	84	96	84	73
All programs*	70	70	70	72	67	68
Electronics	72	78	67	76	74	63
Computer	72	73	71	76	66	—
Graphics	63	62	63	65	62	58
Electrical	62	63	61	59	61	—
Mechanical	70	69	72	66	82	—
Architectural	79	78	81	78	84	—
Civil	77	81	72	74	82	75
Manufacturing	69	66	73	64	83	—
General	77	70	82	92	49	—
Industrial	82	69	95	90	66	—
Chemical	68	71	—	—	—	—
Aeronautical	76	—	—	—	—	—

* *Figures for all programs combine responses from all fields including those omitted from separate presentation.*
— *Insufficient cases for estimation.*

Program mix — a standard program mix was modeled from field reports (see survey question 5 in Appendix C). Colleges with programs in at least four engineering technology fields, a program in electronics, and programs in at least two of the next four most popular fields are standard; those that do not meet all three criteria are classified as other.

Integration with the community — colleges are low integration if they have no cooperative programs, industry arrangements, or arrangements with secondary schools, or if the college has more than five programs but only one type of linkage; medium colleges have one or two types of linkages; and high integration colleges have all three (see survey question 7 in Appendix C).

NOTE: Numbers of programs presented in Table A-29.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Table A-22

Arrangements for student transfer from 2-year colleges to 4-year programs in engineering technology fields, by college commitment and teaching emphasis: 1993

Engineering technology field	Total	College commitment to technology education			College teaching emphasis		
		High	Medium	Low	Applied	Balanced	Theoretical
	Percent						
All colleges	86	86	87	84	78	90	92
All programs*	70	72	64	68	59	73	83
Electronics	72	76	67	—	71	72	—
Computer	72	78	59	—	54	79	—
Graphics	63	65	51	—	46	69	—
Electrical	62	67	42	—	46	67	—
Mechanical	70	73	64	—	57	74	—
Architectural	79	77	77	—	74	80	—
Civil	77	82	74	—	70	75	—
Manufacturing	69	67	69	—	51	79	—
General	77	78	79	—	—	82	—
Industrial	82	83	—	—	—	84	—
Chemical	68	71	—	—	—	61	—
Aeronautical	76	82	—	—	—	—	—

* *Figures for all programs combine responses from all fields including those omitted from separate presentation.*
— *Insufficient cases for estimation.*

Commitment to technology education was gauged for five goals on a 5-point scale (see survey question 3 in Appendix C). Responses were summed and split into three groups: those with 15 or fewer total points are low commitment colleges; those with between 16 and 19 points are medium commitment colleges; and those with 20 or more points are high commitment colleges.

Teaching emphasis by program was reported on a 5-point scale ranging from applied to theoretical (see survey question 6 in Appendix C). Program reports were averaged within colleges and divided into three groups. Applied colleges had average values under 2.5; balanced colleges had average values between 2.5 and 3.5; and theoretical colleges had average values over 3.5.

NOTE: Numbers of programs presented in Table A-30.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Table A-23

Faculty size and teaching status in engineering technology fields in 2-year colleges, by program mix and integration with the community: 1993

Engineering technology faculty	Total (N=691)	Engineering technology program mix: Standard (N=269)	Engineering technology program mix: Other (N=422)	Integration with the community: High (N=260)	Integration with the community: Medium (N=268)	Integration with the community: Low (N=163)
Total faculty						
Total number	11,700	6,741	4,960	5,779	3,963	1,958
Mean number per college	17	25	12	23	15	12
Mean number per program	3	4	3	4	3	2
Status						
Full time						
Total number	6,753	3,660	3,093	2,997	2,271	1,485
Mean number	10	14	8	12	9	9
Percent of total	58	54	62	52	57	76
Part time						
Total number	4,747	2,880	1,866	2,587	1,692	467
Mean number	7	11	5	10	6	3
Percent of total	41	43	38	45	43	24
Ratio of full time to part time	1.42	1.27	1.66	1.16	1.34	3.18

Program mix — a standard program mix was modeled from field reports (see survey question 5 in Appendix C). Colleges with programs in at least four engineering technology fields, a program in electronics, and programs in at least two of the next four most popular fields are standard; those that do not meet all three criteria are classified as other.

Integration with the community — colleges are low integration if they have no cooperative programs, industry arrangements, or arrangements with secondary schools, or if the college has more than five programs but only one type of linkage; medium colleges have one or two types of linkages; and high integration colleges have all three (see survey question 7 in Appendix C).

NOTE: Details may not sum to totals because of rounding.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Table A-24

Faculty size and teaching status in engineering technology fields in 2-year colleges, by college commitment and teaching emphasis: 1993

Engineering technology faculty	Total (N=691)	College commitment to technology education: High (N=388)	Medium (N=195)	Low (N=108)	College teaching emphasis: Applied (N=247)	Balanced (N=375)	Theoretical (N=70)
Total faculty							
Total number	11,700	7,825	2,596	1,279	4,522	6,574	604
Mean number per college	17	21	14	12	18	18	9
Mean number per program	3	3	3	3	4	3	2
Status							
Full time							
Total number	6,753	4,423	1,469	861	2,768	3,659	326
Mean number	10	12	8	8	11	10	5
Percent of total	58	57	57	67	61	56	54
Part time							
Total number	4,747	3,202	1,127	417	1,754	2,721	272
Mean number	7	9	6	4	7	8	5
Percent of total	41	41	43	33	39	41	45
Ratio of full time to part time	1.42	1.38	1.30	2.06	1.58	1.34	1.20

Commitment to technology education was gauged for five goals on a 5-point scale (see survey question 3 in Appendix C). Responses were summed and split into three groups: those with 15 or fewer total points are low commitment colleges; those with between 16 and 19 points are medium commitment colleges; and those with 20 or more points are high commitment colleges.

Teaching emphasis by program was reported on a 5-point scale ranging from applied to theoretical (see survey question 6 in Appendix C). Program reports were averaged within colleges and divided into three groups. Applied colleges had average values under 2.5; balanced colleges had average values between 2.5 and 3.5; and theoretical colleges had average values over 3.5.

NOTE: Details may not sum to totals because of rounding.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Table A-25

Faculty degrees in engineering technology fields in 2-year colleges, by program mix and integration with the community: 1993

Engineering technology faculty	Total (N=691)	Engineering technology program mix: Standard (N=269)	Engineering technology program mix: Other (N=422)	Integration with the community: High (N=260)	Integration with the community: Medium (N=268)	Integration with the community: Low (N=163)
Total faculty						
Total number	11,700	6,741	4,960	5,779	3,963	1,958
Mean number per college	17	25	12	23	15	12
Mean number per program	3	4	3	4	3	2
Highest degree						
Associate's degree						
Total number	688	290	399	280	173	235
Mean number	1	1	1	1	1	2
Percent of full time	10	8	13	9	8	16
Bachelor's degree						
Total number	1,549	799	750	705	413	431
Mean number	2	3	2	3	2	3
Percent of full time	23	22	24	24	18	29
Master's degree						
Total number	2,889	1,635	1,254	1,500	897	492
Mean number	4	6	3	6	4	3
Percent of full time	43	45	41	50	39	33
Professional engineering degree						
Total number	695	346	348	243	328	124
Mean number	1	1	1	1	1	1
Percent of full time	10	9	11	8	14	8
Doctoral degree						
Total number	382	199	184	201	96	86
Mean number	1	1	0	1	0	1
Percent of full time	6	5	6	7	4	6
Some other degree						
Total number	175	42	133	26	64	85
Mean number		0	0	0	0	1
Percent of full time	3	1	4	1	3	6

. Less than .5

Program mix — a standard program mix was modeled from field reports (see survey question 5 in Appendix C). Colleges with programs in at least four engineering technology fields, a program in electronics, and programs in at least two of the next four most popular fields are standard; those that do not meet all three criteria are classified as other.

Integration with the community — colleges are low integration if they have no cooperative programs, industry arrangements, or arrangements with secondary schools, or if the college has more than five programs but only one type of linkage; medium colleges have one or two types of linkages; and high integration colleges have all three (see survey question 7 in Appendix C).

NOTE: Details may not sum to totals because of rounding.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Table A-26

Faculty degrees in engineering technology fields in 2-year colleges, by college commitment and teaching emphasis: 1993

Engineering technology faculty	Total (N=691)	College commitment to technology education: High (N=388)	Medium (N=195)	Low (N=108)	College teaching emphasis: Applied (N=247)	Balanced (N=375)	Theoretical (N=70)
Total faculty							
Total number	11,700	7,825	2,596	1,279	4,522	6,574	604
Mean number per college	17	21	14	12	18	18	9
Mean number per program	3	3	3	3	4	3	2
Highest degree							
Associate's degree							
Total number	688	376	221	91	331	348	10
Mean number	1	1	1	1	1	1	0
Percent of full time	10	9	15	11	12	10	3
Bachelor's degree							
Total number	1,549	997	407	145	837	681	30
Mean number	2	3	2	1	3	2	0
Percent of full time	23	23	28	17	30	19	9
Master's degree							
Total number	2,889	1,987	593	310	1,040	1,648	200
Mean number	4	6	3	3	4	5	3
Percent of full time	43	45	40	36	38	45	61
Professional engineering degree							
Total number	695	454	119	122	302	355	39
Mean number	1	1	1	1	1	1	1
Percent of full time	10	10	8	14	11	10	12
Doctoral degree							
Total number	382	235	74	74	107	230	45
Mean number	1	1	0	1	0	1	1
Percent of full time	6	5	5	9	4	6	1
Some other degree							
Total number	175	61	26	88	62	111	3
Mean number		0	0	1	0	0	0
Percent of full time	3	1	2	10	2	3	1

Less than .5

Commitment to technology education was gauged for five goals on a 5-point scale (see survey question 3 in Appendix C). Responses were summed and split into three groups: those with 15 or fewer total points are low commitment colleges; those with between 16 and 19 points are medium commitment colleges; and those with 20 or more points are high commitment colleges.

Teaching emphasis by program was reported on a 5-point scale ranging from applied to theoretical (see survey question 6 in Appendix C). Program reports were averaged within colleges and divided into three groups. Applied colleges had average values under 2.5; balanced colleges had average values between 2.5 and 3.5; and theoretical colleges had average values over 3.5.

NOTE: Details may not sum to totals because of rounding.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Table A-27

Administrators' ratings of aspects of engineering technology instruction in 2-year colleges, by program mix and integration with the community: 1993*

Aspect of instruction	Total (N=691)	Engineering technology program mix: Standard (N=269)	Engineering technology program mix: Other (N=422)	Integration with the community: High (N=260)	Integration with the community: Medium (N=268)	Integration with the community: Low (N=163)
	Mean					
Students						
Academic preparation of entering students	2.4	2.4	2.3	2.4	2.3	2.3
Student interest and motivation	3.4	3.5	3.4	3.4	3.5	3.4
Computer background of students	2.5	2.8	2.4	2.6	2.6	2.4
Retention rates of majors	3.0	3.0	3.1	3.1	3.0	3.0
Program mix						
Quality of instructional materials	3.7	3.8	3.7	3.6	3.8	3.7
Opportunities for cooperative education internships	2.6	2.9	2.5	3.1	2.5	1.9
Opportunities for innovation in the program mix	3.5	3.5	3.5	3.7	3.6	3.1
Impact of accreditation requirements on program mix development	3.6	3.7	3.5	3.5	3.7	3.5
Laboratory equipment for instruction						
Quality of computer equipment	3.7	3.8	3.7	3.6	3.8	3.7
Amount of computer equipment	3.5	3.5	3.5	3.4	3.6	3.5
Accessibility of computer equipment	3.7	3.6	3.7	3.5	3.8	3.7
Quality of other instructional laboratory equipment	3.4	3.4	3.4	3.3	3.4	3.4
Amount of other instructional laboratory equipment	3.3	3.3	3.3	3.1	3.3	3.5
Accessibility of other instructional laboratory equipment	3.4	3.4	3.4	3.2	3.5	3.5
Funding for instructional laboratory equipment	2.5	2.4	2.6	2.3	2.5	2.8
Facilities for instruction						
Quality of instructional laboratory space	3.6	3.6	3.6	3.5	3.7	3.8
Amount of instructional laboratory space	3.4	3.4	3.4	3.2	3.5	3.6
Demonstration capabilities of lecture facilities	3.4	3.4	3.4	3.2	3.6	3.4
Faculty/staff resources						
Appropriateness of class sizes	4.0	4.1	4.0	4.0	4.0	4.1
Recruitment of qualified faculty	3.7	3.7	3.7	3.8	3.5	3.8
Retention of qualified faculty	4.1	4.2	4.0	4.1	4.0	4.1
Funding for faculty salaries	3.1	3.2	3.1	3.3	2.9	3.2
Oral communication skills of faculty	3.9	3.9	3.9	4.0	3.9	4.0
Faculty sensitivity to students with diverse backgrounds	3.9	3.9	3.9	3.6	4.1	3.9

**Aspects of instruction were rated on a 5-point scale, with a score of "1" indicating "very poor" and a score of "5" indicating "very good."*

Program mix — a standard program mix was modeled from field reports (see survey question 5 in Appendix C). Colleges with programs in at least four engineering technology fields, a program in electronics, and programs in at least two of the next four most popular fields are standard; those that do not meet all three criteria are classified as other.

Integration with the community — colleges are low integration if they have no cooperative programs, industry arrangements, or arrangements with secondary schools, or if the college has more than five programs but only one type of linkage; medium colleges have one or two types of linkages; and high integration colleges have all three (see survey question 7 in Appendix C).

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Table A-28

Administrators' ratings of aspects of engineering technology instruction in 2-year colleges, by college commitment and teaching emphasis: 1993*

Aspect of instruction	Total (N=691)	College commitment to technology education: High (N=388)	Medium (N=195)	Low (N=108)	College teaching emphasis: Applied (N=247)	Balanced (N=375)	Theoretical (N=70)
	Mean						
Students							
Academic preparation of entering students	2.4	2.3	2.4	2.4	2.3	2.3	2.7
Student interest and motivation	3.4	3.5	3.4	3.3	3.5	3.5	3.3
Computer background of students	2.5	2.6	2.4	2.4	2.5	2.5	2.6
Retention rates of majors	3.0	3.1	2.9	3.3	3.0	3.1	2.9
Program mix							
Quality of instructional materials	3.7	3.8	3.7	3.5	3.8	3.7	3.4
Opportunities for cooperative education internships	2.6	2.8	2.4	2.3	2.6	2.7	2.4
Opportunities for innovation in the program mix	3.5	3.7	3.5	3.1	3.5	3.7	3.1
Impact of accreditation requirements on program mix development	3.6	3.8	3.3	3.3	3.6	3.6	3.0
Laboratory equipment for instruction							
Quality of computer equipment	3.7	3.8	3.7	3.7	3.9	3.7	3.1
Amount of computer equipment	3.5	3.6	3.4	3.4	3.7	3.5	2.7
Accessibility of computer equipment	3.7	3.7	3.6	3.6	3.9	3.6	3.0
Quality of other instructional laboratory equipment	3.4	3.5	3.2	3.3	3.5	3.4	3.0
Amount of other instructional laboratory equipment	3.3	3.4	3.1	3.2	3.5	3.2	3.0
Accessibility of other instructional laboratory equipment	3.4	3.4	3.4	3.4	3.6	3.4	3.0
Funding for instructional laboratory equipment	2.5	2.6	2.4	2.4	2.6	2.4	2.6
Facilities for instruction							
Quality of instructional laboratory space	3.6	3.8	3.4	3.6	3.8	3.6	3.3
Amount of instructional laboratory space	3.4	3.5	3.2	3.5	3.6	3.3	3.4
Demonstration capabilities of lecture facilities	3.4	3.6	3.1	3.3	3.4	3.5	3.2
Faculty/staff resources							
Appropriateness of class sizes	4.0	4.1	4.0	3.6	4.1	3.8	4.5
Recruitment of qualified faculty	3.7	3.8	3.6	3.4	3.5	3.8	3.6
Retention of qualified faculty	4.1	4.2	4.0	3.7	4.0	4.1	4.1
Funding for faculty salaries	3.1	3.3	2.9	2.8	2.9	3.3	3.1
Oral communication skills of faculty	3.9	4.1	3.9	3.6	3.9	4.0	4.0
Faculty sensitivity to students with diverse backgrounds	3.9	4.0	3.6	3.8	3.7	3.9	4.3

**Aspects of instruction were rated on a 5-point scale, with a score of "1" indicating "very poor" and a score of "5" indicating "very good."*

Commitment to technology education was gauged for five goals on a 5-point scale (see survey question 3 in Appendix C). Responses were summed and split into three groups: those with 15 or fewer total points are low commitment colleges; those with between 16 and 19 points are medium commitment colleges; and those with 20 or more points are high commitment colleges.

Teaching emphasis by program was reported on a 5-point scale ranging from applied to theoretical (see survey question 6 in Appendix C). Program reports were averaged within colleges and divided into three groups. Applied colleges had average values under 2.5; balanced colleges had average values between 2.5 and 3.5; and theoretical colleges had average values over 3.5.

NOTE: Details may not sum to totals because of rounding.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Table A-29

Estimated number of programs in engineering technology fields in 2-year colleges, by program mix and integration with the community: 1993

Engineering technology field	Total	Engineering technology program mix		Integration with the community		
		Standard	Other	High	Medium	Low
	Number					
All programs*	3,637	1,902	1,733	1,594	1,249	795
Electronics	571	269	301	229	222	119
Computer	384	181	203	159	139	85
Graphics	368	192	176	159	133	76
Electrical	341	185	156	136	131	75
Mechanical	347	193	153	134	129	83
Architectural	284	159	125	143	79	62
Civil	290	159	131	106	102	82
Manufacturing	270	156	114	146	85	39
General	220	104	116	97	61	62
Industrial	169	89	80	76	58	36
Chemical	122	73	48	66	28	28
Aeronautical	74	46	29	44	14	17

**Figures for all programs combine responses from all fields including those omitted from separate presentation.*

Program mix — a standard program mix was modeled from field reports (see survey question 5 in Appendix C). Colleges with programs in at least four engineering technology fields, a program in electronics, and programs in at least two of the next four most popular fields are standard; those that do not meet all three criteria are classified as other.

Integration with the community — colleges are low integration if they have no cooperative programs, industry arrangements, or arrangements with secondary schools, or if the college has more than five programs but only one type of linkage; medium colleges have one or two types of linkages; and high integration colleges have all three (see survey question 7 in Appendix C).

NOTE: Details may not sum to totals because of rounding.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Table A-30

Estimated numbers of programs in engineering technology fields in 2-year colleges, by college commitment and teaching emphasis: 1993

Engineering technology field	Total	College commitment to technology education			College teaching emphasis		
		High	Medium	Low	Applied	Balanced	Theoretical
	Number						
All programs*	3,637	2,267	913	456	1,124	2,119	395
Electronics	571	333	172	66	203	308	60
Computer	384	225	104	56	107	237	40
Graphics	368	237	69	61	116	216	36
Electrical	341	208	81	52	111	181	49
Mechanical	347	221	96	30	123	185	39
Architectural	284	171	78	34	100	167	17
Civil	290	187	75	29	83	167	40
Manufacturing	270	178	67	25	87	171	13
General	220	130	62	27	60	116	44
Industrial	169	121	31	17	47	106	17
Chemical	122	81	31	10	14	84	24
Aeronautical	74	57	15	2	20	47	7

**Figures for all programs combine responses from all fields including those omitted from separate presentation.*

Commitment to technology education was gauged for five goals on a 5-point scale (see survey question 3 in Appendix C). Responses were summed and split into three groups: those with 15 or fewer total points are low commitment colleges; those with between 16 and 19 points are medium commitment colleges; and those with 20 or more points are high commitment colleges.

Teaching emphasis by program was reported on a 5-point scale ranging from applied to theoretical (see survey question 6 in Appendix C). Program reports were averaged within colleges and divided into three groups. Applied colleges had average values under 2.5; balanced colleges had average values between 2.5 and 3.5; and theoretical colleges had average values over 3.5.

NOTE: Details may not sum to totals because of rounding.

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

APPENDIX B
TECHNICAL NOTES

The National Science Foundation, the U.S. Department of Education, and the National Endowment for the Humanities established the **Higher Education Surveys** (HES) system to conduct small-scale studies of higher education topics of interest to federal policy makers and the education community.

The HES panel is a nationally representative sample of 1,134 U.S. colleges and universities. HES questionnaires typically request a limited amount of readily accessible data from a subsample of institutions in the HES panel. Each institution has identified a campus representative who facilitates data collection by identifying the appropriate respondents for each survey and distributing survey forms to the respondents.

HES 17 Survey Methodology. The sample for this survey consisted of the 364 2-year colleges in the HES panel. Data collection consisted of a mail questionnaire with telephone followup. In January of 1993, survey questionnaires were mailed to HES coordinators at all 364 institutions. Data collection efforts continued for 9 weeks and were concluded with a response rate of 92 percent.

Table B-1

Response rates for the HES 17 survey

2-year colleges in HES panel	364
In scope for HES 17	347
Refused	8
Blank	21
Complete	318
Response rate	92%

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

Reliability of Survey Estimates. The findings presented in this report are estimates based on the sample from the HES panel and, consequently, are subject to sampling variability. If the questionnaire had been sent to a different sample, the responses would not have been identical; some figures might have been higher, while others might have been lower.

The standard error is a measure of variability due to sampling when estimating a statistic. It indicates the variability in the population of possible estimates of a parameter for a given sample size. Standard errors can be used as a measure of the precision expected from a particular sample.

If all possible samples from the same population were surveyed under similar conditions, intervals of 1.96 standard errors below to 1.96 standard errors above a particular statistic would include the true population parameter being estimated in about 95 percent of the samples. This is the 95 percent confidence interval. For example, the estimated percentage of 2-year colleges with engineering technology programs that have cooperative arrangements is 53 percent, and the estimated standard error is 3.51. The 95 percent confidence interval for this statistic extends from 53 − (3.51 x 1.96) to 53 + (3.51 x 1.96), or from 45.76 to 59.50 percent. This means one can be 95 percent confident that this interval contains the true population value. Estimates of standard errors for the data were computed using a technique known as jackknife replication. Some key representative statistics and their estimated standard errors are shown in Table B.2.

Table B-2

Standard errors for selected statistics

Institutional characteristic	Estimate	Standard error	95% confidence interval	
			Lower	Upper
2-year colleges with engineering technology divisions (N=691)				
Percentage offering engineering technology associate's degrees	99	0.35	98.72	100.07
Percentage offering engineering technology certificates	65	3.02	59.14	71.00
Percentage with cooperative arrangements	53	3.51	45.76	59.50
Percentage with arrangements to train workers	63	3.26	56.93	69.69
Percentage with tech-prep arrangements	62	3.95	54.10	69.56
Percentage with arrangements for student transfer	86	3.11	79.58	91.76
Percentage rating as very important to their schools:				
Provision of entry-level skills in science-based technical fields	77	2.84	71.51	82.63
Continuing education in science-based technical fields	54	3.79	46.23	61.10
Transfer courses in science-based technical fields	71	4.51	62.14	79.84
Percentage with engineering technology course enrollment of 300 or more	40	3.37	33.72	46.94
Percentage offering electronics engineering technology	83	3.36	76.27	89.45
Percentage offering computer engineering technology	56	2.88	49.91	61.19
Percentage offering graphics engineering technology	54	2.70	48.44	59.04
Percentage offering electrical engineering technology	51	3.21	44.27	56.83
Percentage offering mechanical engineering technology	50	3.47	42.70	56.32
2-year colleges with science technology divisions (N=446)				
Percentage offering science technology associate's degrees	96	1.98	91.87	99.64
Percentage offering science technology certificates	69	3.84	61.17	76.23
Percentage with cooperative arrangements	72	4.42	62.96	80.29
Percentage with arrangements to train workers	49	4.27	40.76	57.50
Percentage with tech-prep arrangements	53	3.29	46.86	59.77
Percentage with arrangements for student transfer	81	2.61	76.31	86.56
Percentage rating as very important to their schools:				
Provision of entry-level skills in science-based technical fields	74	3.75	67.14	81.84
Continuing education in science-based technical fields	56	5.41	45.02	66.23
Transfer courses in science-based technical fields	78	3.52	71.53	85.34
Percentage with science technology course enrollment of over 100	48	5.55	36.74	58.51
Percentage offering agricultural technology	46	4.37	37.63	54.75
Percentage offering biotechnology	31	5.85	19.93	42.88
Percentage offering chemical technology	43	3.76	36.06	50.81
Percentage offering environmental technology	34	4.04	26.31	42.14
Percentage offering food science technology	24	3.14	17.62	29.92

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

For categorical data, relationships between variables with two or more levels have been tested in a two-way analysis, using chi-square tests at the .05 level of significance, adjusted for average design effect. If the overall chi-square test was significant, it was followed with tests using a Bonferroni t statistic, which maintained an overall 95 percent confidence level or better. Unless noted otherwise, all comparisons discussed in this report were statistically significant using these tests.

Survey estimates are also subject to errors of reporting and errors made in the collection of the data. These errors, called nonsampling errors, can sometimes bias the data. While general sampling theory can sometimes be used to determine how to estimate the sampling variability of a statistic, nonsampling errors are not easy to measure and usually require that an experiment be conducted as part of the data collection procedures or the use of data external to the study.

Nonsampling errors may include such factors as differences in the respondents' interpretations of the meaning of the questions, differences related to the particular time the survey was conducted, or errors in data preparation. During the design of the survey and survey pretest, an effort was made to check for consistency of interpretation of questions and to eliminate ambiguous items. The questionnaire was pretested with respondents like those who completed the survey, and the questionnaire and instructions were extensively reviewed by the National Science Foundation. Manual and machine editing of the questionnaires were conducted to check the data for accuracy and consistency. Cases with missing or inconsistent items were recontacted by telephone; data were keyed with 100 percent verification.

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Relationships of Institutional Characteristics. The data in this report are presented as "total" figures, which represent all engineering technology institutions or science technology institutions grouped together, and for engineering technology institutions broken down by engineering technology field mix, integration with the community, commitment to technology education, and college teaching emphasis (see Table B-3). These classifications are as follows:

1. Engineering technology field mix
   - Standard colleges offer engineering technology programs in at least four fields, have a program in electronics engineering technology (the most popular field), and have programs in at least two of the next four most popular fields (computer, graphics, electrical, and mechanical engineering technology).
   - Other colleges offer engineering technology programs in a nonstandard mix of fields.

2. Integration of engineering technology colleges with the academic and business communities
   - Low integration colleges have no engineering technology cooperative arrangements, industry arrangements, or tech-prep arrangements with secondary schools, or they have just one of these types but offer programs in five or more fields.
   - Medium integration colleges have one or two of these types of linkages.
   - High integration colleges have all three of these linkages.

3. Commitment of engineering technology colleges to technology education based on the importance of five goals (importance was gauged on a 5-point scale)
   - High commitment colleges rated all the goals as highly important.
   - Medium commitment colleges had mean ratings just above the midpoint.
   - Low commitment colleges had mean ratings at the midpoint or below.

4. College teaching emphasis in engineering technology (gauged on a 5-point scale)
   - Applied colleges reported a mean teaching emphasis for their engineering technology programs at the applied end of the scale.
   - Balanced colleges reported a mean teaching emphasis in the middle range of the scale.
   - Theoretical colleges reported a mean teaching emphasis at the theoretical end of the scale.

Table B-3

Institutional characteristics of 2-year colleges with engineering technology divisions (N=691)

Characteristic	Total	Engineering technology field mix		Integration with the community			College teaching emphasis in engineering technology			College commitment to technology education		
		Standard	Other	High	Medium	Low	Applied	Balanced	Theoretical	High	Medium	Low
	Percent											
Engineering technology field mix												
Standard	39	—	—	45	38	18	33	55	12	65	26	9
Other	61	—	—	33	40	27	37	54	9	50	30	20
Integration of engineering technology division with the community												
High	38	46	54	—	—	—	25	66	8	64	26	9
Medium	39	38	62	—	—	—	39	54	7	51	29	20
Low	24	29	71	—	—	—	47	36	17	51	29	20
College teaching emphasis in engineering technology												
Applied	36	36	64	27	42	31	—	—	—	45	35	20
Balanced	54	40	60	46	38	16	—	—	—	63	21	16
Theoretical	10	46	54	31	28	40	—	—	—	59	39	2
College commitment to technology education												
High	56	45	55	43	35	22	29	61	11	—	—	—
Medium	28	36	64	35	40	25	45	41	14	—	—	—
Low	16	23	77	22	49	29	45	54	1	—	—	—

SOURCE: Technical Education in 2-Year Colleges (HES 17), National Science Foundation, 1995.

APPENDIX C

QUESTIONNAIRE FOR HES 17

Higher Education Surveys

OMB 3145-0009
Exp. 6/30/94

SURVEY ON TECHNICAL EDUCATION
IN 2-YEAR INSTITUTIONS

Winter 1993

Dear Colleague,

On behalf of the National Science Foundation (NSF), I invite you to participate in this Higher Education Survey of technical education in 2-year institutions. This is the first study of technical education in 2-year institutions conducted by NSF. The questionnaire requests descriptive information which includes data on degrees and transfer arrangements and agreements.

NSF is now actively involved in programs to promote improvements in the quality of science technology and engineering technology education in 2-year institutions. In order to develop new programs, evaluate existing programs, and meet Congressional reporting requirements, information is needed on engineering technology and science technology at 2-year schools. We reviewed the national data currently being collected and have avoided duplication in data collection efforts.

The survey is being conducted for NSF as part of the Higher Education Surveys (HES) system. The data are being collected by Westat, Inc., of Rockville, Maryland. A copy of the HES report will be sent to your institution after this study is complete. If you have any questions about this survey, please call.

Thank you in advance for your assistance. I look forward to your help with this important project.

Sincerely,

Robert F. Watson, Ph.D.,
Director, Division of Undergraduate Science,
Engineering, and Mathematics Education
National Science Foundation

Sponsored by the National Science Foundation, the National Endowment for the Humanities, and the U.S. Department of Education

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I. Science-Based Technical Fields to Include on this Form

This form was designed to collect information about the engineering technology and science technology fields listed below. (These are the science-based technical fields ordinarily supported by the National Science Foundation.) Any programs in these fields that teach fundamental scientific, mathematical, or engineering concepts should be included.

A. Engineering Technology Fields to Include:

1. Aeronautical engineering technology
2. Architectural engineering technology
3. Chemical engineering technology
4. Civil engineering technology
5. Computer engineering technology
6. Electrical engineering technology
7. Electronics engineering technology
8. Engineering/computer graphics technology
9. General engineering technology
10. Industrial engineering technology
11. Manufacturing engineering technology
12. Marine engineering technology
13. Mechanical engineering technology ,
14. Mining/metallurgy engineering technology
15. Nuclear engineering technology
16. Other engineering technology

B. Science Technology Fields to Include:

1. Agricultural technology
2. Biotechnology
3. Chemical technology
4. Environmental technology
5. Food science technology
6. Hazardous materials technology
7. Marine science technology
8. Materials technology
9. Wood science technology
10. Other science technology

II. Fields and Programs to Exclude from this Form:

Exclude technical programs that are *exclusively applied*, and the *clinical health fields*, such as medicine, nursing, and other allied health fields.

If you are not sure whether to include a particular program, please call

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I. Institutional Organization

1. Which of the following describe your institution?

		YES	NO
a.	A single-campus 2-year college not affiliated with any other 2-year or 4-year college campus	1	2
b.	A multi-campus 2-year college	1	2
c.	Part of a 2-year college system or district	1	2
d.	Part of a college system that includes both 2-year and 4-year colleges	1	2
e.	Other	1	2

(DESCRIBE: _____)

2. Please examine the fields listed under I.A. and I.B. on the inside front cover of this form. What percent of the students enrolled at your institution are taking courses or pursuing degrees in the science-based technical fields listed there?

Percent of students in science-based technical fields listed ..... _____%

INSTRUCTION:
If no students are taking courses or pursuing degrees in the science-based technical fields listed, check here [ ] and skip to the respondent information section on page 12; otherwise continue.

3. How important are each of the following goals to the mission of your institution:

		IMPORTANCE				
		NOT				VERY
a.	A specific commitment to science-based technical occupations?	1	2	3	4	5
b.	Provision of training in entry-level skills for employment in science-based technical fields?	1	2	3	4	5
c.	Provision of continuing education for those currently employed in science-based technical fields?	1	2	3	4	5
d.	Provision of first and second year courses in science-based technical fields for students who wish to transfer into 4-year programs?	1	2	3	4	5
e.	Provision of remediation for students who are not adequately prepared for science-based technical coursework at the college level?	1	2	3	4	5

4. Of all courses offered by your institution in fall 1992, what percent were taught by part-time faculty members?

a. In all fields? ..... _____%

b. In the listed engineering technology fields? ..... _____%

c. In the listed science technology fields? ..... _____%

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II. Engineering Technology

5. How extensive is the involvement of your institution in engineering technology education? Specifically, for each of the engineering technology fields listed below:

In **Column A**, indicate whether your institution offers courses in that field. For fields where you answer "no" to Column A, skip Columns B through E.

In **Column B**, indicate whether your institution confers certificates in that field.

In **Column C**, indicate whether your institution confers associate's degrees in that field.

In **Column D**, report the total course enrollment in that field for the fall of 1992. Students enrolled in more than one course in a given field should be counted for each course. For example, a student enrolled in two civil technology courses would be counted twice in Column D.

In **Column E**, indicate whether the course enrollment for that field has gone up by 5 percent or more, has stayed the same, or has gone down by 5 percent or more, between fall 1989 and fall 1992.

Engineering technology field	A. Offer courses?	B. Confer certificates?	C. Confer associate's degrees?	D. Course enrollment for fall 1992	E. Course enrollment from 1989-1992 gone up, stayed the same, or gone down?
	YES NO	YES NO	YES NO	NUMBER	UP SAME DOWN
a. Aeronautical	1 2	1 2	1 2	_____	1 2 3
b. Architectural	1 2	1 2	1 2	_____	1 2 3
c. Chemical	1 2	1 2	1 2	_____	1 2 3
d. Civil	1 2	1 2	1 2	_____	1 2 3
e. Computer	1 2	1 2	1 2	_____	1 2 3
f. Electrical	1 2	1 2	1 2	_____	1 2 3
g. Electronics	1 2	1 2	1 2	_____	1 2 3
h. Engineering/computer graphics	1 2	1 2	1 2	_____	1 2 3
i. General	1 2	1 2	1 2	_____	1 2 3
j. Industrial	1 2	1 2	1 2	_____	1 2 3
k. Manufacturing	1 2	1 2	1 2	_____	1 2 3
l. Marine	1 2	1 2	1 2	_____	1 2 3
m. Mechanical	1 2	1 2	1 2	_____	1 2 3
n. Mining/metallurgy	1 2	1 2	1 2	_____	1 2 3
o. Nuclear	1 2	1 2	1 2	_____	1 2 3
p. Other (SPECIFY) _____	1 2	1 2	1 2	_____	1 2 3

INSTRUCTION:
If your institution does not offer courses in any of the engineering technology fields listed in question 5, check here [ ] and skip to question 13; otherwise continue.

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6. What is the relative emphasis placed on teaching applied skills versus teaching fundamental science and mathematics in your engineering technology programs? For each of the engineering technology fields listed below in which your institution offers courses, rate the emphasis.

   Assign a "1" to those fields where there is an exclusive emphasis on teaching applied skills.

   Assign a "2" to those fields where there is more emphasis on teaching applied skills than on teaching fundamental science and mathematics.

   Assign a "3" to those fields where there is equal emphasis on teaching both.

   Assign a "4" to those fields where there is more emphasis on teaching fundamental science and mathematics than on teaching applied skills.

   Assign a "5" to those fields where there is an exclusive emphasis on teaching fundamental science and mathematics.

Engineering technology field	Program emphasis				
	Emphasis on applied skills		Equal emphasis		Emphasis on fundamental science and mathematics
a. Aeronautical	1	2	3	4	5
b. Architectural	1	2	3	4	5
c. Chemical engineering	1	2	3	4	5
d. Civil	1	2	3	4	5
e. Computer	1	2	3	4	5
f. Electrical	1	2	3	4	5
g. Electronics	1	2	3	4	5
h. Engineering/computer graphics	1	2	3	4	5
i. General	1	2	3	4	5
j. Industrial	1	2	3	4	5
k. Manufacturing	1	2	3	4	5
l. Marine	1	2	3	4	5
m. Mechanical	1	2	3	4	5
n. Mining/metallurgy	1	2	3	4	5
o. Nuclear	1	2	3	4	5
p. Other (specify)	1	2	3	4	5

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7. What types of agreements or arrangements for training and transfer of engineering technology students does your institution have? Specifically, for each of the engineering technology fields listed below in which your institution offers courses:

In **Column A**, indicate whether your institution has work-based programs involving employers and/or labor unions to train students to work in that field (e.g., cooperative education programs, school to apprenticeship programs, or feeder programs).

In **Column B**, indicate whether your institution has agreements or arrangements with industry to train or retrain workers in that field.

In **Column C**, indicate whether your institution has articulation agreements or arrangements with any secondary districts or schools to jointly offer tech-prep programs that provide at least 2 years of secondary and 2 years of postsecondary courses leading to associate's degrees or 2-year certificates in that field.

In **Column D**, indicate whether your institution has articulation agreements or other arrangements with any 4-year colleges or college systems to facilitate the transfer of students to 4-year degree programs in that field.

Engineering technology field	A. Any co-op programs or work-based arrangements to train students?	B. Any arrangements with industry to train or retrain workers?	C. Any arrangements with secondary schools?	D. Any arrangements for student transfer to 4-year program?
	YES NO	YES NO	YES NO	YES NO
a. Aeronautical	1 2	1 2	1 2	1 2
b. Architectural	1 2	1 2	1 2	1 2
c. Chemical	1 2	1 2	1 2	1 2
d. Civil	1 2	1 2	1 2	1 2
e. Computer	1 2	1 2	1 2	1 2
f. Electrical	1 2	1 2	1 2	1 2
g. Electronics	1 2	1 2	1 2	1 2
h. Engineering/computer graphics	1 2	1 2	1 2	1 2
i. General	1 2	1 2	1 2	1 2
j. Industrial	1 2	1 2	1 2	1 2
k. Manufacturing	1 2	1 2	1 2	1 2
l. Marine	1 2	1 2	1 2	1 2
m. Mechanical	1 2	1 2	1 2	1 2
n. Mining/metallurgy	1 2	1 2	1 2	1 2
o. Nuclear	1 2	1 2	1 2	1 2
p. Other (specify) _____	1 2	1 2	1 2	1 2

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8. What are the major issues and concerns confronting your engineering technology program?

In **Column A**, rate the aspects of instruction in engineering technology at your institution, with a rating of "1" meaning very poor, and "5" meaning very good. For aspects that are not applicable, circle "0."

In **Column B**, pick the 5 aspects from the whole list that present the greatest problems for your engineering technology program and rank them, with a "1" assigned to the greatest problem, a "2" to the second greatest, etc.

If you feel there are no problems in your engineering technology program, check here [ ], and skip Column B.

Aspect of instruction in engineering technology	A. Rate the aspects (Not applicable / Very poor / Very good)	B. Rank the top 5 problems on this page
a. Students		
1. Academic preparation of entering students	0 1 2 3 4 5	_____
2. Student interest and motivation	0 1 2 3 4 5	_____
3. Computer background of students	0 1 2 3 4 5	_____
4. Retention rates of majors	0 1 2 3 4 5	_____
b. Curriculum		
1. Quality of instructional materials	0 1 2 3 4 5	_____
2. Opportunities for cooperative education/internships	0 1 2 3 4 5	_____
3. Opportunities for innovation in the curriculum	0 1 2 3 4 5	_____
4. Impact of accreditation requirements on curriculum development	0 1 2 3 4 5	_____
c. Laboratory equipment for instruction		
1. Quality of computer equipment	0 1 2 3 4 5	_____
2. Amount of computer equipment	0 1 2 3 4 5	_____
3. Accessibility of computer equipment	0 1 2 3 4 5	_____
4. Quality of other instructional laboratory equipment	0 1 2 3 4 5	_____
5. Amount of other instructional laboratory equipment	0 1 2 3 4 5	_____
6. Accessibility of other instructional laboratory equipment	0 1 2 3 4 5	_____
7. Funding for instructional laboratory equipment	0 1 2 3 4 5	_____
d. Facilities for instruction		
1. Quality of instructional laboratory space	0 1 2 3 4 5	_____
2. Amount of instructional laboratory space	0 1 2 3 4 5	_____
3. Demonstration capabilities of lecture facilities	0 1 2 3 4 5	_____
e. Faculty/staff resources		
1. Appropriateness of class sizes	0 1 2 3 4 5	_____
2. Recruitment of qualified faculty	0 1 2 3 4 5	_____
3. Retention of qualified faculty	0 1 2 3 4 5	_____
4. Funding for faculty salaries	0 1 2 3 4 5	_____
5. Oral communication skills of faculty	0 1 2 3 4 5	_____
6. Faculty sensitivity to students with diverse backgrounds	0 1 2 3 4 5	_____
f. Other (SPECIFY) _____	0 1 2 3 4 5	_____

g. With which field of engineering technology are you most directly involved?

_____

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9. How many faculty members taught engineering technology in fall 1992?

   a. Total number of faculty ..... _____

   b. Number of part-time faculty ..... _____

   c. Number of full-time faculty (IF NONE, SKIP TO QUESTION 11) ..... _____

10. Indicate the highest degrees of the full-time faculty members reported in question 9c above.

   a. Number with associate's degree ..... _____

   b. Number with bachelor's degree ..... _____

   c. Number with master's degree ..... _____

   d. Number with professional engineering degree ..... _____

   e. Number with doctoral degree ..... _____

   f. Number with some other degree ..... _____

11. What can NSF do to improve instruction in engineering technology at 2-year institutions?

_____

_____

_____

_____

_____

_____

12. Would you like to receive information on NSF programs targeted to 2-year institutions?

   Yes 1

   No 2

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III. Science Technology

13. How extensive is the involvement of your institution in science technology education? Specifically, for each of the science technology fields listed below:

In **Column A**, indicate whether your institution offers courses in that field. For fields where you answer "no" to Column A, skip Columns B through E.

In **Column B**, indicate whether your institution confers certificates in that field.

In **Column C**, indicate whether your institution confers associate's degrees in that field.

In **Column D**, report the total course enrollment in that field for the fall of 1992. Students enrolled in more than one course in a given field should be counted for each course. For example, a student enrolled in two chemical technology courses would be counted twice in Column D.

In **Column E**, indicate whether the course enrollment for that field has gone up by 5 percent or more, has stayed the same, or has gone down by 5 percent or more, between fall 1989 and fall 1992.

Science technology field	A. Offer courses?	B. Confer certificates?	C. Confer associate's degrees?	D. Course enrollment for fall 1992	E. Course enrollment from 1989-1992 gone up, stayed the same, or gone down?
	YES NO	YES NO	YES NO	NUMBER	UP SAME DOWN
a. Agricultural	1 2	1 2	1 2	_____	1 2 3
b. Biotechnology	1 2	1 2	1 2	_____	1 2 3
c. Chemical	1 2	1 2	1 2	_____	1 2 3
d. Environmental	1 2	1 2	1 2	_____	1 2 3
e. Food science	1 2	1 2	1 2	_____	1 2 3
f. Hazardous materials	1 2	1 2	1 2	_____	1 2 3
g. Marine science	1 2	1 2	1 2	_____	1 2 3
h. Materials	1 2	1 2	1 2	_____	1 2 3
i. Wood science	1 2	1 2	1 2	_____	1 2 3
j. Other (specify) _____	1 2	1 2	1 2	_____	1 2 3

INSTRUCTION:
If your institution does not offer courses in any of the science technology fields listed in question 13, check here [ ] and skip to the respondent information section on page 12; otherwise continue.

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14. What is the relative emphasis placed on teaching applied skills versus teaching fundamental science and mathematics in your science technology programs? For each of the science technology fields listed below in which your institution offers courses, rate the emphasis.

Assign a "1" to those fields where there is an exclusive emphasis on teaching applied skills.

Assign a "2" to those fields where there is more emphasis on teaching applied skills than on teaching fundamental science and mathematics.

Assign a "3" to those fields where there is equal emphasis on teaching both.

Assign a "4" to those fields where there is more emphasis on teaching fundamental science and mathematics than on teaching applied skills.

Assign a "5" to those fields where there is an exclusive emphasis on teaching fundamental science and mathematics.

Science technology field	Program emphasis				
	Emphasis on applied skills		Equal emphasis		Emphasis on fundamental science and mathematics
a. Agricultural	1	2	3	4	5
b. Biotechnology	1	2	3	4	5
c. Chemical	1	2	3	4	5
d. Environmental	1	2	3	4	5
e. Food science	1	2	3	4	5
f. Hazardous materials	1	2	3	4	5
g. Marine science	1	2	3	4	5
h. Materials	1	2	3	4	5
i. Wood science	1	2	3	4	5
j. Other (specify) _____	1	2	3	4	5

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15. What types of agreements or arrangements for training and transfer of science technology students does your institution have? Specifically, for each of the science technology fields listed below in which your institution offers courses:

In **Column A**, indicate whether your institution has work-based programs involving employers and/or labor unions to train students to work in that field (e.g., cooperative education programs, school to apprenticeship programs, or feeder programs).

In **Column B**, indicate whether your institution has agreements or arrangements with industry to train or retrain workers in that field.

In **Column C**, indicate whether your institution has articulation agreements or arrangements with any secondary districts or schools to jointly offer tech-prep programs that provide at least 2 years of secondary and 2 years of postsecondary courses leading to associate's degrees or 2-year certificates in that field.

In **Column D**, indicate whether your institution has articulation agreements or other arrangements with any 4-year colleges or college systems to facilitate the transfer of students to 4-year degree programs in that field.

Science technology field	A. Any co-op programs or work-based arrangements to train students?	B. Any arrangements with industry to train or retrain workers?	C. Any arrangements with secondary schools?	D. Any arrangements for student transfer to 4-year program?
	YES NO	YES NO	YES NO	YES NO
a. Agricultural	1 2	1 2	1 2	1 2
b. Biotechnology	1 2	1 2	1 2	1 2
c. Chemical	1 2	1 2	1 2	1 2
d. Environmental	1 2	1 2	1 2	1 2
e. Food science	1 2	1 2	1 2	1 2
f. Hazardous materials	1 2	1 2	1 2	1 2
g. Marine science	1 2	1 2	1 2	1 2
h. Materials	1 2	1 2	1 2	1 2
i. Wood science	1 2	1 2	1 2	1 2
j. Other (SPECIFY) _____	1 2	1 2	1 2	1 2

16. What are the major issues and concerns confronting your science technology program?

In **Column A**, rate the aspects of instruction in science technology at your institution, with a rating of "1" meaning very poor, and "5" meaning very good. For aspects that are not applicable, circle "0".

In **Column B**, pick the 5 aspects from the whole list that present the greatest problems for your science technology program and rank them, with a "1" assigned to the greatest problem, a "2" to the second greatest, etc.

If you feel there are no problems in your science technology program, check here [ ], and skip Column B.

Aspect of instruction in engineering technology	A. Rate the aspects: Not applicable	Very poor				Very good	B. Rank the top 5 problems on this page
a. Students							
1. Academic preparation of entering students	0	1	2	3	4	5	_____
2. Student interest and motivation	0	1	2	3	4	5	_____
3. Computer background of students	0	1	2	3	4	5	_____
4. Retention rates of majors	0	1	2	3	4	5	_____
b. Curriculum							
1. Quality of instructional materials	0	1	2	3	4	5	_____
2. Opportunities for cooperative education/internships	0	1	2	3	4	5	_____
3. Opportunities for innovation in the curriculum	0	1	2	3	4	5	_____
4. Impact of accreditation requirements on curriculum development	0	1	2	3	4	5	_____
c. Laboratory equipment for instruction							
1. Quality of computer equipment	0	1	2	3	4	5	_____
2. Amount of computer equipment	0	1	2	3	4	5	_____
3. Accessibility of computer equipment	0	1	2	3	4	5	
4. Quality of other instructional laboratory equipment	0	1	2	3	4	5	_____
5. Amount of other instructional laboratory equipment	0	1	2	3	4	5	_____
6. Accessibility of other instructional laboratory equipment	0	1	2	3	4	5	_____
7. Funding for instructional laboratory equipment	0	1	2	3	4	5	_____
d. Facilities for instruction							
1. Quality of instructional laboratory space	0	1	2	3	4	5	_____
2. Amount of instructional laboratory space	0	1	2	3	4	5	_____
3. Demonstration capabilities of lecture facilities	0	1	2	3	4	5	_____
e. Faculty/staff resources							
1. Appropriateness of class sizes	0	1	2	3	4	5	_____
2. Recruitment of qualified faculty	0	1	2	3	4	5	_____
3. Retention of qualified faculty	0	1	2	3	4	5	_____
4. Funding for faculty salaries	0	1	2	3	4	5	_____
5. Oral communication skills of faculty	0	1	2	3	4	5	_____
6. Faculty sensitivity to students with diverse backgrounds	0	1	2	3	4	5	_____
f. Other (SPECIFY) _____	0	1	2	3	4	5	_____

g. With which field of science technology are you most directly involved?

_____

17. How many faculty members taught science technology in fall 1992?

    a. *Total number of faculty* ..... _____

    b. Number of part-time faculty ..... _____

    c. Number of full-time faculty (if none, skip to question 19) ..... _____

18. Indicate the highest degrees of the full-time faculty members reported in question 17c above.

    a. Number with associate's degree ..... _____

    b. Number with bachelor's degree ..... _____

    c. Number with master's degree ..... _____

    d. Number with professional engineering degree ..... _____

    e. Number with doctoral degree ..... _____

    f. Number with some other degree ..... _____

19. What can NSF do to improve instruction in science technology at 2-year institutions?

    _____

    _____

    _____

    _____

    _____

    _____

    _____

20. Would you like to receive information on NSF programs targeted to 2-year institutions?

    Yes 1

    No 2

Respondent Information Section

May we have your permission to release these data to the National Science Foundation with your institutional identification code? This would allow NSF to use data from other surveys to help analyze the results. All information published by NSF will be in aggregate form only.

Yes 1

No 2

Please sign: _____

Thank you for your assistance.
Please return this form by January 29, 1993 to:

Higher Education Surveys
WESTAT
1650 Research Boulevard
Rockville, MD 20850

Who completed the **institutional organization** section of this form?

Name: _____
Title: _____
Department name: _____
Telephone: _____

Who completed the **engineering** technology section of this form?

Name: _____
Title: _____
Department name: _____
Telephone: _____

Who completed the **science** technology section of this form?

Name: _____
Title: _____
Department name: _____
Telephone: _____

Please keep a copy of this survey for your records.

If you have any questions or problems concerning this survey, please call.

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